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Engineering News-Record

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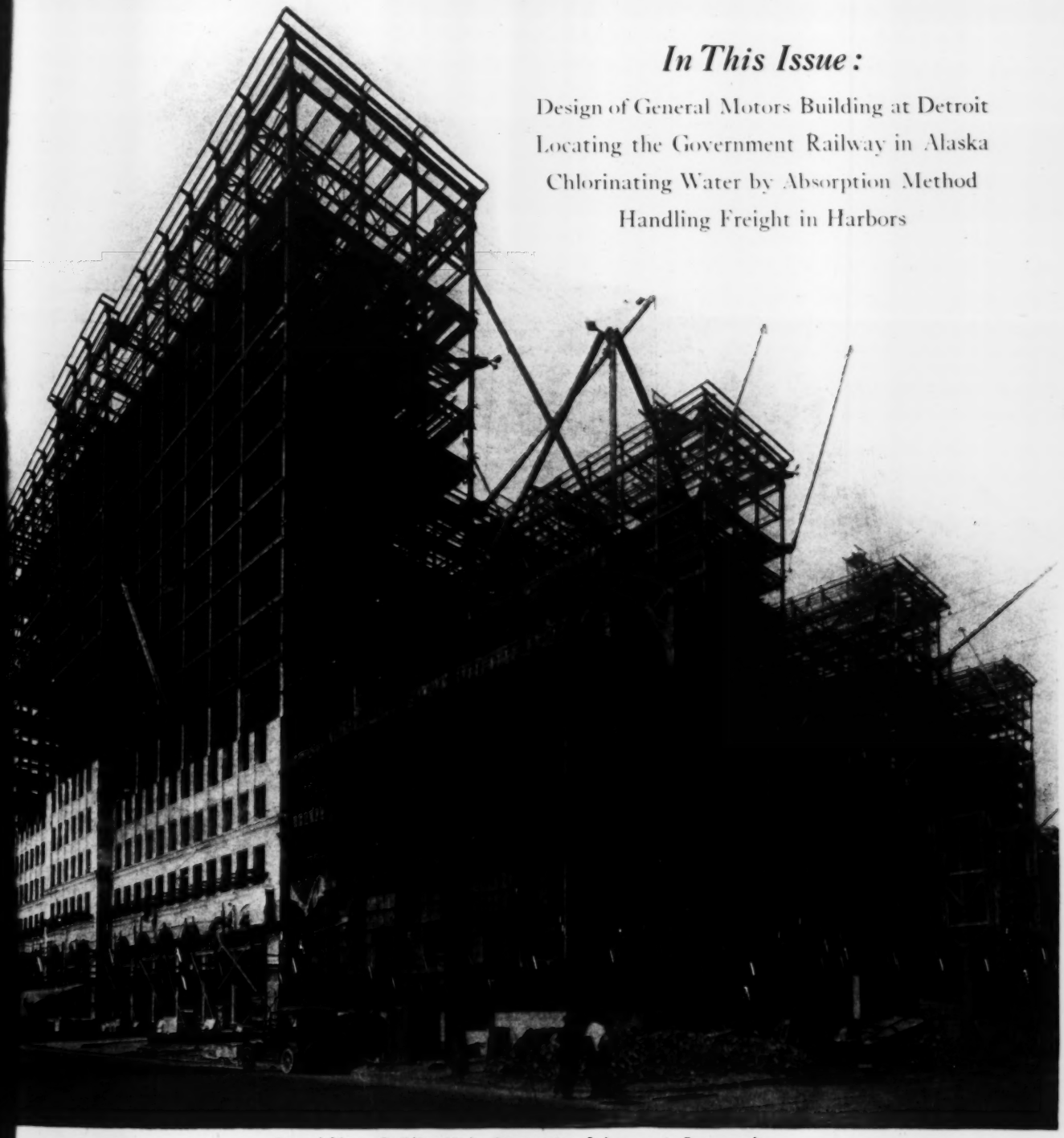

General Motors Building Under Construction; Laboratory in Foreground

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

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Load Limit for Soft Roads

ACTING upon authority given to him by the legislature on March 17, the state highway commissioner of New Hampshire has prohibited vehicles of more than 3 tons gross weight from using the trunk line, cross state or state-aid highways from March 21 until further notice. The order was issued to protect the highways during the period of spring road softening and will be rescinded as soon as conditions permit. Rulings of similar purport have been made before, though less drastic. The Connecticut limit, for the early spring season last year, was fixed at 10 tons as compared with a normal maximum gross load of 12½ tons. The 3-ton gross weight limit for New Hampshire, therefore, represents a decidedly radical reduction in allowable weight. It will, in large measure, rule the motor truck temporarily off the highway. Regulations of this sort obviously must be based on the type and condition of roads. Connecticut, with a considerable mileage of hard-surfaced roads can allow a higher load limit than can New Hampshire, where dirt and gravel roads are the prevailing types. The restrictions, even though they are temporary, are evidence of a commendable determination to conserve the money which the state has put into its road system.

Menace of German Exportations

RELATIVELY little attention has been given to the menace which heavy German exportations will have on the United States. The matter, however, is not a whit less important to us than to England and France. Both of them desire Germany to have a huge export trade—*but not to their countries.* They do not want to be undersold at home. However, Germany's goods, going into world trade, will compete with the goods of all other nations, and with ours as well. Germany's differential will be very considerable. Further than that, we are now rich, compared with other nations, and are looked upon to take a big volume of German products. If we do, there may be serious industrial disturbance here. Since Germany cannot pay fully in gold or by transfer of investments in other countries, she must export goods and labor, the labor either crystallized in goods or the labor itself. It is just the last that Germany has repeatedly said she wants to export. She has proposed to rebuild the devastated regions with German labor and German materials. Heretofore France has not been willing to accept the offer, but it is now reported that French labor has withdrawn its objections. Let us hope that that is true, and that the French Government, likewise, will fall in with the plan. From the standpoint of the three nations most concerned—England, France, and ourselves—the best solution would be such an exportation of German materials and German labor. Difficulties are involved, of course; the French, for example, pretend to fear the Germanization of northern France, but such difficulties are minor compared with the world-wide trade disturbance that would result from the forcing of huge quantities of German goods, at low prices, into world trade.

State Harbor Control

WHILE New York harbor is apparently in process of being transferred from city to state control just the reverse operation is taking place at San Francisco. There, the case for local control is being made, as noted in the news pages, solely on the rights of the city and the necessity of home rule, while the opposition largely depends on charges of possible municipal inefficiency and corruption. The issue is much broader than this; it centers around the future development of San Francisco bay as a great shipping harbor and not around the rights and privileges of the city of San Francisco. Sooner or later that wide bay, with its modern port developments on the west and with its transcontinental terminals on the east, must be developed as a unit and the rival demands and facilities of its dozen cities compromised. So long as the state controls San Francisco it will be an easy matter to extend control to the other cities and to round out a balanced development, but once let the city take over its own front years of controversy and delay will be ahead. The situation in the port of New York today should be a beacon by which the legislators of California may steer.

Dust Explosions

DUST explosions are commonly recognized as one of the hazards in certain industries and establishments, such, for example, as grain elevators, plants manufacturing grain products, sugar refineries, etc. The introductory paragraph of an article in this issue, however, indicates that dust explosions may be expected in many industries beyond those with which such explosions are commonly associated. That the possibility of their occurrence should be taken into consideration by the mechanical engineers of such industries goes without further emphasis, but is there not an obligation here, also, for the structural engineer? Manifestly the removal of the dust is a primary engineering problem. Its removal, however, may be intimately associated with the details of a structure—such, for example, as the design of the housings around grain elevator legs—and therefore a matter that the structural engineer must take into consideration. Furthermore, since dust explosions should be recognized as a hazard, it is proper to take into consideration in the design of structures for those industries such construction as will minimize the damage when an explosion actually occurs. This Mr.

Price urges in his article. He advocates curtain instead of bearing walls for the exteriors of structures, and commends large window areas, particularly when filled with self-supporting steel sash. The thought may be a new one to most structural designers, but with the records of damage that are available it is apparent that it is a matter for the structural engineer's consideration.

The "Sand-Hog" to Reappear

FRIGHTENED into retirement by the shadow of the recent world conflict, like the prophetic ground-hog, the New York "sand-hog," according to present indications, will soon reappear after a long period of hibernation. The announcement of the contract schedule for the Hudson River vehicular tunnels in the 1920 annual report of the New York-New Jersey commissions, made public recently, fixes May 15 as the date on which the plans, specifications and contracts for the 29-ft. twin tubes will be ready. Unless unforeseen delays occur, actual work under the river should be in progress shortly after that date. The announcement heralds the resumption of a type of engineering work in which no new projects have been undertaken since the United States entered the war. During the period of construction of the Pennsylvania's East River and North River tunnels, the Hudson tubes, and the subways connecting Manhattan and Brooklyn, New York City became the world's most important compressed-air tunnel center. In those days the sand-hog, always a dramatic figure, by reason of the risks of his calling, frequently found his way into the public prints. The engineering profession is his debtor, for it was largely through him that the public became acquainted with the magnitude and importance of great public and private engineering projects which, without his human interest touch, would have proceeded unheralded and unappreciated. The sand-hog was the best press-agent that the engineering profession ever had, and we welcome his return.

All-Year-Round Track Work

THE USUAL arrangement of track work involves building up practically new labor forces each spring. Spreading the work evenly over the entire year is by no means easy (see *Engineering News-Record* of March 17, p. 449) but some railways have found that enough maintenance work, even in the North, can be economically done in winter to hold continuously not only a skilled force but a reduced force of so-called "common" labor as well. A severe winter with heavy snows will prevent continuous maintenance, but then forces are required to keep line and yards clear. The work is often emergency work, better done by the loyal "company" man than by the casual laborer. In a mild winter, there is opportunity for much continuous work, with resulting absence of bad spring track and a condition that is virtually "deferred maintenance," more expensive to repair. As pointed out by Mr. Morse of the Rock Island, at the convention of the American Railway Engineering Association, much track work requires skilled labor, in spite of the general impression that any man who works on the track is a common laborer. These skilled men, at least, should be retained, the gangs being increased by common labor if necessary during the busiest seasons. Economy and efficiency of track work depend largely upon interest and loyalty hardly to be expected of temporary employees.

Politics Attacks Highway Departments

POLITICAL attacks on state highway departments have been particularly vicious during the past few months. A survey of the several lines of battle indicates each to have been laid down with the view of establishing the ascendency of political control of road location and construction. Ostensibly, of course, the purpose is quite different. It presumably is a patriotic attempt to reduce costs and eliminate extravagant standards.

Such efforts are being made in Illinois, Indiana and Missouri. The Illinois situation revolves about high prices for roads of high standard. In Missouri the struggle is to get the designation of state roads into the hands of the legislature. In Indiana the county organizations recently deprived of a large part of their road funds and the perquisites therefrom are trying to get back what they have lost. The Indiana situation is a plain struggle for local initiative and control of highway development. Such an arrangement is more to the liking of politicians than is centralized control by a well organized state highway department.

It is interesting to note how high prices and recent congressional action have temporarily strengthened the politicians. High prices have given them an opportunity to proclaim extravagance—a charge to which the public always gives attention. Congress, by its failure to make a new federal-aid appropriation has deprived state highway departments, in many states, of the strongest argument they possessed against the advocates of local independence in highway improvement.

It has taken much work to bring state highway departments to their present relatively satisfactory level of operation. All forces interested in public welfare must unite to prevent retrogression.

A Step Toward a Port of New York

UNLESS something unexpected intervenes the treaty or compact between the States of New Jersey and New York for the joint control of New York harbor is now assured. There thus comes into being a political entity rare if not entirely new in American government, an interstate appointed body with all the powers legally vested in, but only occasionaly exercised by, the state itself. The Port Authority may "purchase, construct, lease or operate any terminal or transportation facility, . . . make charges for the use thereof . . . own, hold, lease or operate real or personal property, borrow money and secure the same by bonds and mortgages . . ." Thus far it is in supreme charge of that great national, state and city asset, the port of New York, and in that respect it has been attacked as a usurpation of local authority. The fact is, however, that the compact as written constitutes such a supreme authority only insofar as the states and cities concerned are agreeable. The co-ordination of the port must depend on the co-operation of its separate parts.

In the first place the Port Authority cannot begin to function until the two states have adopted a "comprehensive plan" for port development. Such a plan, presumably, is what the recent interstate port commission has just submitted, but it is inconceivable that the legislatures will vote to adopt any plan unless the prospective chronology of the scheme is definitely stated so that each party to the agreement may have some idea of

its proportionate benefit. Any plan adopted, too, must take years to complete, years in which errors in the scheme will be revealed. But the plan will have been fixed, and to change it recourse must again be had to the legislatures; co-operation must be continuous.

The case of the cities within the port district is even more definite. None of their property can be taken without their consent nor can they be financially obligated unless they so agree. Furthermore, they may proceed as they please on their individual schemes of port development. In other words, the proposed Manhattan belt-line tunnel cannot be built unless New York City permits the use of the ground beneath its streets and Jersey City or even one of the smaller boroughs of New Jersey can block the outer belt railway. Every step in any comprehensive plan will involve the consent of one or more of the many municipalities, and the proper working of the plan will be disturbed, to say the least, by any individual development out of harmony with the combined development.

The new compact, then, merely provides the machinery for a unified port and a directing head which should be able to compromise the various interests. This, indeed, is a great step forward toward the kind of thinking and building that the port of New York has been sadly needing these many years, but the desired end cannot be reached unless every party sinks its short sighted provincialism in a common effort to better the whole port, and thereby bring proportionate benefit to itself.

British Miners' Strike and Its Moral for American Labor

Before this issue reaches its readers the British coal miners' strike will probably be compromised. The very seriousness of the stoppage would forecast an early termination, while as this is written (Monday) negotiations that are regarded as hopeful are under way.

England has had serious strikes since the armistice—the railroad workers and the coal miners have both tied up the country. The present contest is due to an attempt on the part of the miners to hold what, after long effort, they succeeded in getting during the war, nation-wide agreements on wages. Before the war, wages varied in accordance with the profitableness of the coal fields. The rich districts paid higher wages than the poor districts for the same kind of work. For years the miners have had as their great goal the wiping out of these inequalities and they achieved it during the war. Last fall's strike settlement was still on the basis of a national agreement in which it was proposed to substitute before April 1 of this year a permanent wage basis for the temporary one agreed on in the settlement. Though not planned last fall, the end of government control of the industry came simultaneously with the date set for a new basis and negotiations were therefore thrown into the hands of the mine owners and the workers, the government acting as an interested spectator but not as a party to the prospective bargain. The owners immediately took a stand against national agreements, holding that efficiency of operation was impossible unless the districts stood each on its own footing. That meant reversal to the policy of wages proportionate to the mine earning power—a proposal the workers refused to consider. Hence the strike.

It is freely conceded by the miners that on the basis of operating costs the various districts, standing alone, cannot all pay the top wage of the district of cheapest production. They contend, though, that it is unjust to pay different wages for the same work. Obviously no plan could meet the miners' demand except a consolidation of ownership, or, what amounts to the same, a pooling of profits. This the miners recognize.

At this distance, and lacking thorough acquaintance with all the factors, a judgment as to the sound way out is not possible. Evidently there are good reasons against ownership consolidation—aside from the unwillingness of owners of the more profitable to pool their interests with the poorer paying properties.

If it be conceded that such consolidation is out of question then there would seem to be no possibility of settlement, short of government ownership, except on the basis of district agreement.

If the temper of the British public is correctly reported, it will be on that basis that settlement will come, with, however, payment for the miners in proportion to the results attained.

The miners' strike brings to an end the nation-wide profit-sharing scheme for both owners and workers established as a temporary measure by the strike settlement of last year. The agreement ran onto hard days—the ending of government control, the temporary loss of the export market, falling coal prices and, as a necessary accompaniment of the two previous conditions, accumulated coal stocks. Consequently the value of the scheme cannot be appraised. Probably some profit-sharing features will be embodied in the future agreements, but the nation-wide profit-sharing plan for owner and worker, made with government participation and sanction, has come to an end.

Exhibitions such as the British strike make even the most sincere disinterested friend of the labor movement hesitate in his advocacy of the strengthening of the unions. The British miners have gone so far as to permit mines to be flooded—doing heavy, if not irreparable, damage—while the railway and transport workers have voted to strike in sympathy, thus endeavoring to paralyze the country. That approaches close to tyranny.

It is just such exhibitions of ruthless power that strengthens the stand of the dyed-in-the-wool labor-union opponent in this country. Do we want to put ourselves into the power of the unions, as the British public has done? is his question. And he gets a response that shows itself, to cite one instance, in the strength now displayed by the "open-shop" drive.

The English experience and its effect on the American public should be object lessons to the American Federation of Labor. Already that body is visibly troubled by the strong reaction of the public to the high-handedness of labor during the war. It has lost much of the sympathy it was building for itself previous to 1916. Many "open-shop" advocates sincerely believe in the shop where union and non-union men work side by side, but most of them are using the "open-shop" and "American-plan" drives as a cloak for anti union efforts.

Labor strongly organized and intelligently led can be a benefit. Acting as British labor is acting, it will be a menace and will get short shrift. Because of our agricultural population, labor's numbers here are proportionately less than in Britain. Therein lies a condition with which American labor must reckon.

The moral is to have intelligent leadership determined to win sympathy by rectitude and fairness.

Construction Details of General Motors Office Building

Fifteen-Story Structure with Thirty-two Acres of Floor Space to House Six Thousand Persons—Heavy Girders and Columns in Steel Frame—Reinforced-Concrete Laboratory Building

By Joseph Matte, Jr.
Engineer with Albert Kahn, Architect, Detroit.

AN OFFICE building of more than 32 acres floor space which was completed in Detroit during the past year represents a notable structural achievement. Ranking well among the largest office buildings in existence (the Equitable Building in New York City has about 40 acres of floor space), it is furthermore distinguished by unusually complete appointments and by being occupied by a single business, the General Motors Corporation having planned the building for its own use.

The year 1915 marked the beginning of a period of great industrial expansion, and of a corresponding slackening of general building activities, which culminated in 1917 when, all energies and resources being marshalled for the one purpose of winning the war, all building work not intimately connected with the national purpose was brought to a complete standstill. The inception of the General Motors Building marked the resumption of general building construction. It is the most noteworthy structure erected since the close of the war.

Size and Arrangement of Building

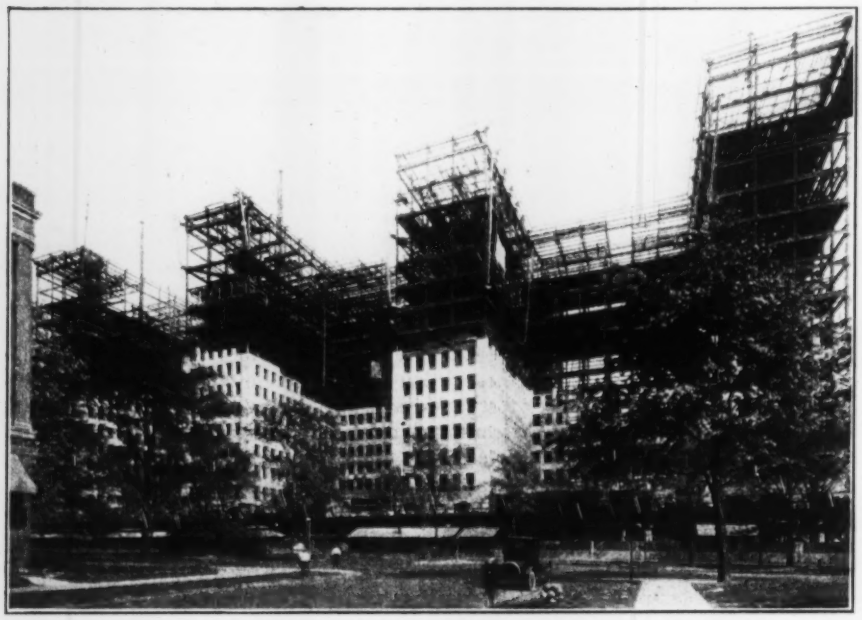
The building, 322 x 504 ft., occupies the block bounded by East Grand Boulevard, Milwaukee, Cass and Second Aves. It consists of two main connected units, the laboratory, 60 x 502 ft., fronting on Milwaukee Ave., and the office building, fronting on the Boulevard, consisting of four wings 52 x 262 ft. connected at the middle by a transept 52 x 504 ft. The basement and first floor of the office building extend over its entire area; the courts between the wings and the transept are roofed over at the second floor level. All exterior and court walls are faced with buff Bedford limestone.

The laboratory is five stories high, with full basement. It is of reinforced-concrete construction with steel-arch roof frame. It will house the chemical, metallurgical and electrical laboratories, and provide space

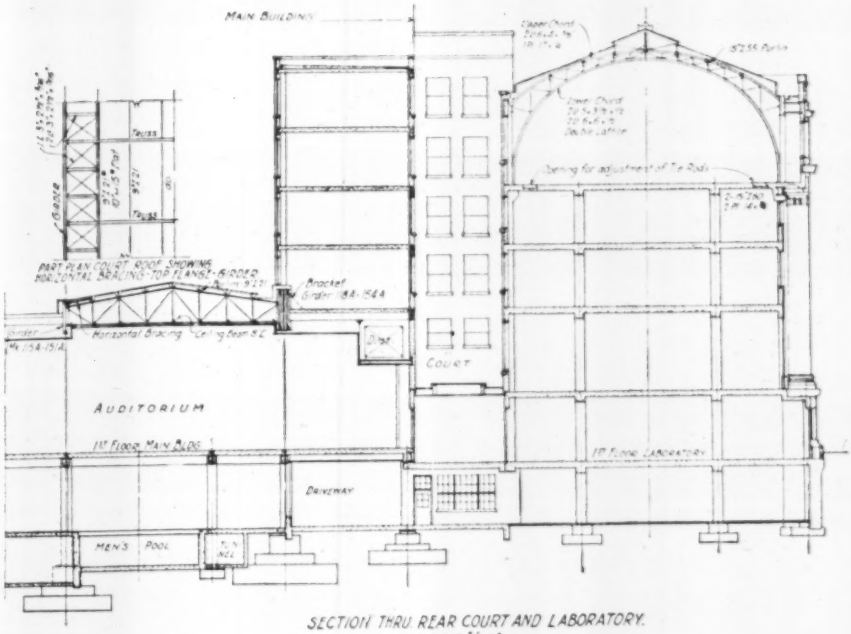
FIVE-STORY LABORATORY BUILDING, 60 x 502 FT., EXTENDS ALONG REAR OF MAIN STRUCTURE

for a large machine shop on the first floor and an exhibition room on the fifth floor.

The office building has a sub-basement extending under the central part, full basement, fifteen main floors, a mezzanine floor between first and second, and a pipe gallery floor below the roof. It is a steel skeleton building with reinforced-concrete floors. It contains in the basement two swimming pools each 25 x 75 ft., a gymnasium, twelve bowling alleys, billiard room, barber shop, mail room connected to the upper part of the building by 28 pneumatic tubes, and supply, stock and utility rooms. On the first floor are eight automobile show rooms, an auditorium seating 1,500 persons, offices, shops, and quarters for a bank and trust company. The second to thirteenth floors will house the offices of the General Motors Corporation, its subsidiary and affiliated companies. Every office is an outside room. The second floor is designed for a live load of 250 lb. to permit the installation of printing machinery or other heavy equipment. The fourteenth floor contains the exec-



FRONT VIEW OF GENERAL MOTORS BUILDING DURING CONSTRUCTION



GIRDER AND TRUSS CONSTRUCTION SEEN IN FRONT-TO-REAR SECTION OF BUILDING

utive offices, living suites, private dining and lunch rooms, and barber shop. The fifteenth floor contains two dining rooms with cafeteria service, capable of serving 6,000 persons in less than an hour and a half, a kitchen of 5,000 sq.ft. area, ladies' rest rooms, men's lounge, and dance hall. Over part of one of the wings, a sixteenth story contains valet's and maid's quarters.

Access to the basement for trucks carrying supplies is obtained by means of a driveway running the full length of the building between the laboratory and the office building, and passing underneath the five-story projections of the wings connecting them to the laboratory. The driveway has a ramp at each end to reach street level. The main entrance and elevator lobby are treated with Tavernelle marble pilasters, and the floors laid over with paneled Tennessee marble. The corridors are floored over with gray Tennessee marble, and wainscoted with white Alabama marble. The corridor doors are hollow metal. The interior doors of offices and the window trim are of American walnut.

The building has a floor area of about 1,400,000 sq.ft. and a population capacity of 6,000 people. It is served by four freight elevators and 27 passenger elevators. The principal quantities of material required in its construction were as follows: structural steel, 15,000 tons; reinforcing steel, 1,500 tons; brick, 8,790,000; cement, 100,000 bbl.; sand and gravel, 70,000 cu.yd.; fireproofing tile, 290,000 sq. ft.; limestone, 450,000 cu.ft.

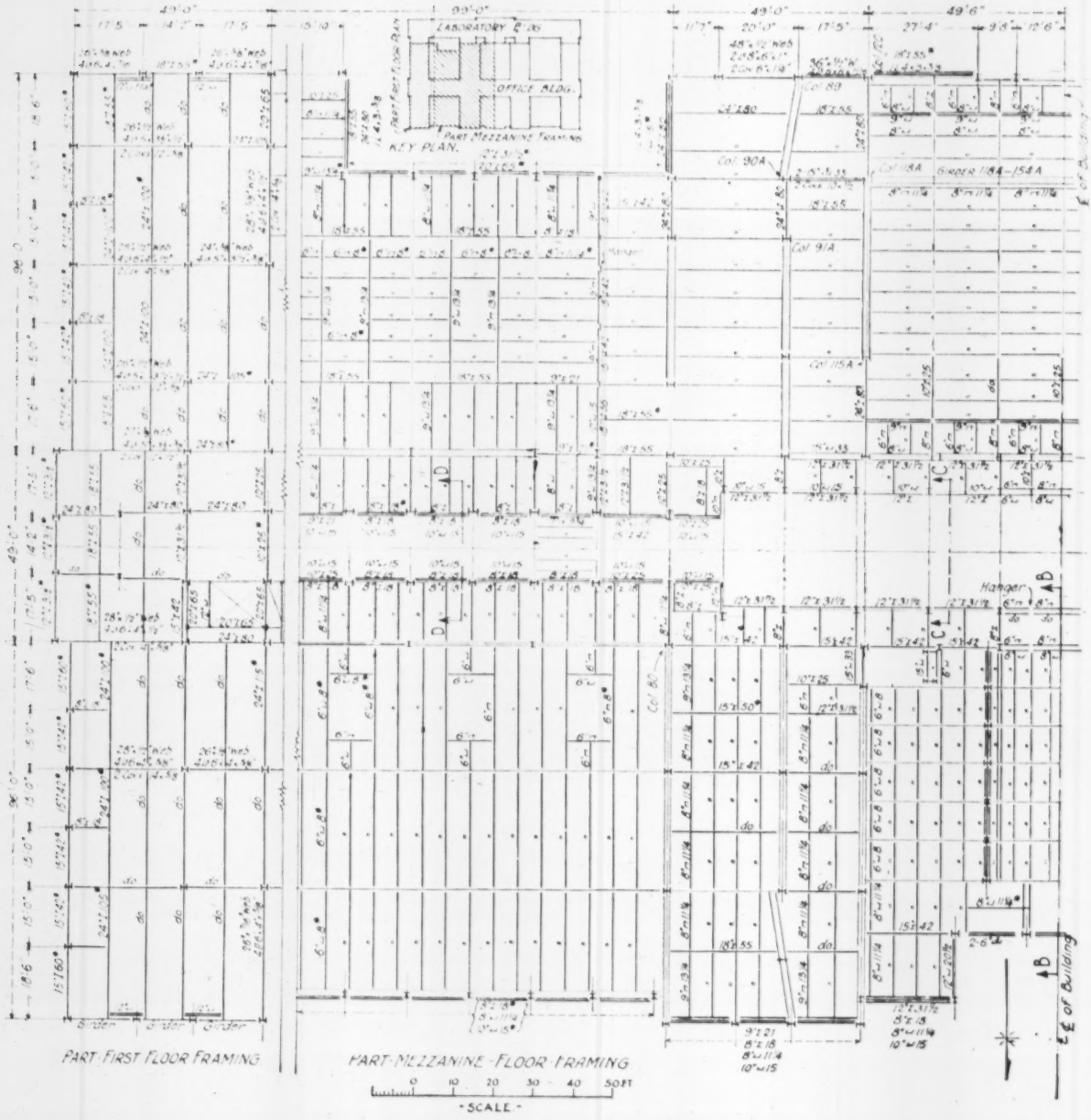
The site of the building was occupied by 26 minor buildings, mostly residences, and the office of the Hyatt Roller Bearing Co. The residences were all dismantled and the material removed. The office building, 60 x 95 ft., was a three-story-and-basement reinforced concrete building erected in 1916, weighing 3,600 tons. It was considered economical to move this building to a new site several hundred feet south of its location, and it was decided to attempt this. The work was entrusted to the F. P. Friestedt Co. of Chicago, who started June 20, 1919. It was entirely successful. While in transit the building was in full use; light, water, and telephone service were uninterrupted.

Foundations and a basement were prepared at the new site. Twelve lines of 12 x 12-in. moving timbers, supported by 225 jacks, received the load of the building. The jacks rested on hardwood skids carried by 6-in. maple rollers on running tracks placed on cribbing. The 12 x 12-in. moving timbers were connected in pairs by a loop of 1¼-in. steel cable. These loops were attached to three 90-hp. double-drum electric hoisting engines by means of 12,000 ft. of ¾-in. cable reeved through five sets of 3-in. sheave blocks and one set of 6-in. blocks.

The average progress of moving was 60 ft. per day, the maximum, 101 ft. in one day, when the building crossed Milwaukee Ave. The total cost for repairs to plastering and other work was only $50.

Basement excavation required the removal of 130,000

THREE-HINGED STEEL ARCH ROOF OF LABORATORY BUILDING



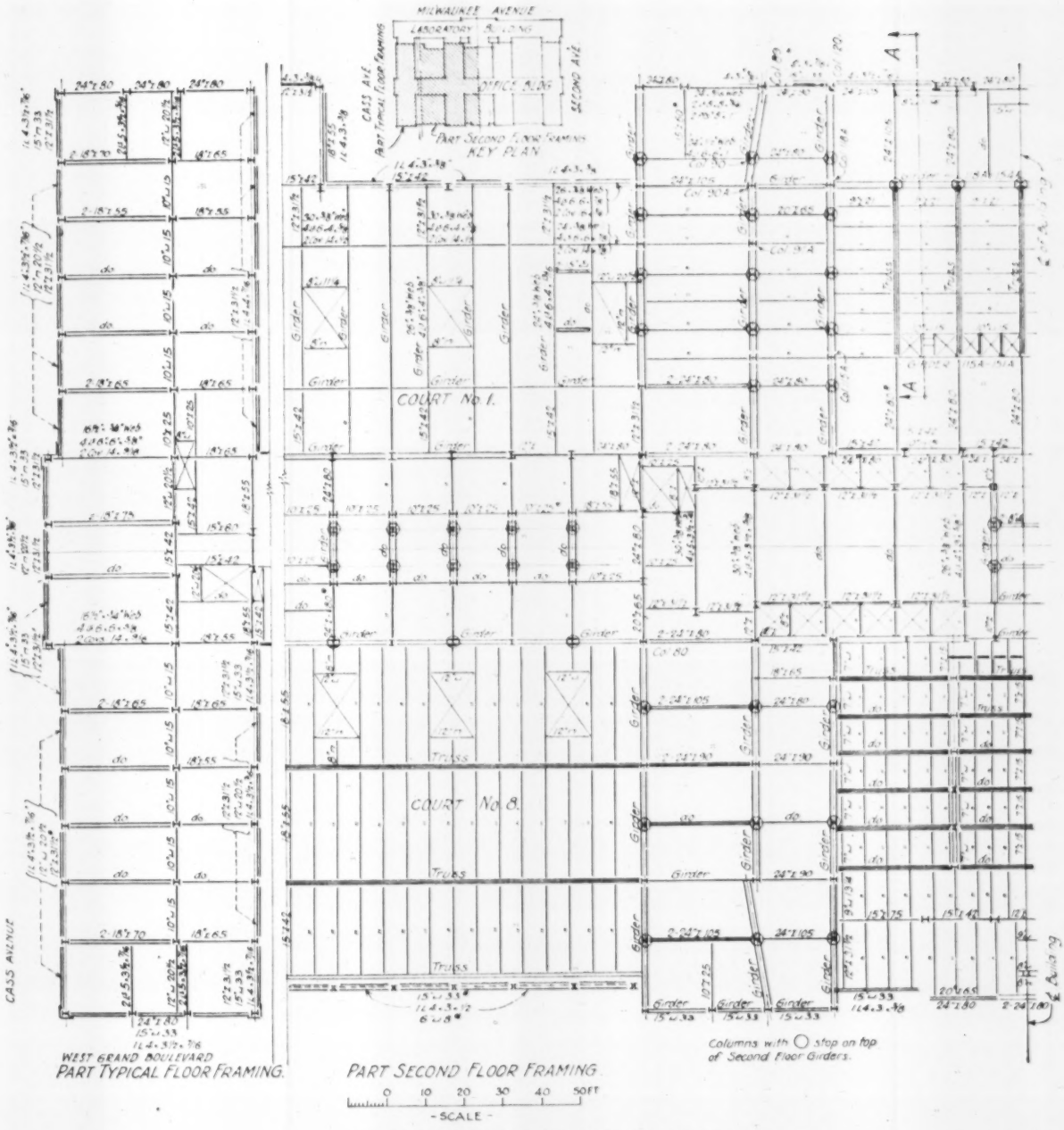
FRAMING OF FIRST AND MEZZANINE FLOORS

cu.yd. of material, mostly yellow and blue clay. This was handled by three steam shovels and from 30 to 40 four-ton motor trucks. Borings 60 ft. below curb had shown an excellent stiff, blue clay, suited to a safe load of 4 tons per sq.ft.

The column foundations were designed as individual concrete footings. In the center of the office building, the columns were spaced so closely that mat footings were used for groups of from 2 to 8 columns per mat. The soil pressure was taken as 8,000 lb. per sq.ft. for interior columns and columns carrying a large percentage of live load, 7,500 sq.ft. for intermediate wall columns, and 7,000 lb. for exterior corner columns.

The retaining walls of the office building are of reinforced concrete, 12 in. thick, with steel spanning vertically from the ground to the first floor. These walls are set about 6 ft. outside the wall columns. Similar walls were used around the sub-basement. The laboratory retaining walls are 18 in. thick, flaring out in the shape of a projecting cornice at the top to receive the stone base course. All such walls were shored temporarily with batter struts until the floors to which they abut were built.

Both swimming pools are supported directly on the ground, and are constructed with 10-in. reinforced-concrete walls containing waterproofing paste. The walls span horizontally to concrete buttresses which also support some of the secondary columns running up to the court roof. The floor slab around the rim of the pool, poured with the walls, forms a thin horizontal beam to stiffen the walls and transfer the pressure to the buttresses and corners; it spans the width of the pipe



FRAMING OF SECOND AND UPPER FLOORS

tunnel surrounding the pool. The floor of the pool, its walls, and the floor along the rim of the pool are covered with membrane waterproofing. A finish coat of concrete 3½ in. thick, recessed at the top to receive the scum trough, was laid over the membrane waterproofing, ready to receive the tile finish.

To obtain as much freedom from vibration as possible the laboratory was built of reinforced concrete. The wall columns are spaced about 13½ ft. on centers, and are connected by concrete spandrel beams supporting the walls and their share of the floor. The two rows of interior columns are spaced 16 ft. from the walls, 28 ft. apart transversely and from 25 to 30 ft. apart longitudinally. They carry two lines of shallow longitudinal concrete beams, which in turn support a floor of concrete joists 14 in. deep and 16 in. apart, with 12-in. hollow-tile fillers between them. This construction, while stiff, permits obtaining openings easily when required through the tile fillers, an advantage in a building of this type.

The roof frame consists of three-hinged steel arches, spaced from 27 to 30 ft. apart, with no other lateral bracing than that afforded by the purlins. The roof covering consists of a 2½-in. concrete slab on metal lath, overlaid with 1½-in. "nalecode," to which Spanish tile finish is secured. Below the slab is hung the plastered ceiling. Additional light is secured through the roof by means of a 12-ft. skylight. The segments of the arch are tied

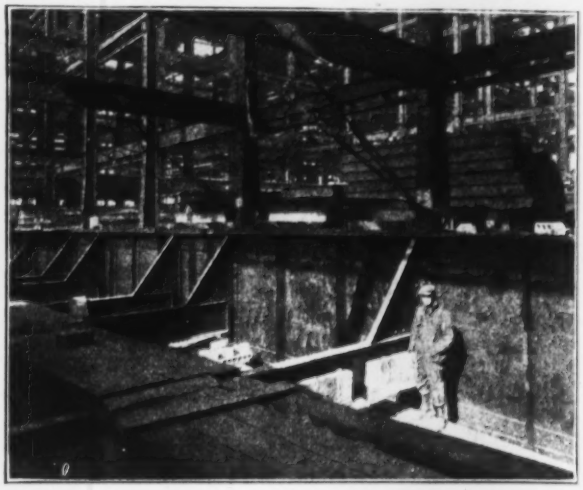
through the floor by rods embedded therein during the pouring, to which connection is made by shackle plates and turnbuckles in a recess left in the concrete construction.

Floor Framing of Office Building

Because of wide column spacing and a design live-load of 125 lb. per sq.ft., the first floor requires the use of many single-web plate girders 26 and 28 in. deep, as well as heavy 24-in. I-sections. The main entrance consists of a loggia, a vestibule and the lobby. The wall dividing the loggia from the vestibule, and the colonnade in the vestibule are situated over the ladies' swimming pool, and are carried by the floor framework.

Tho so-called mezzanine floor framing comprises the supports for the moving-picture room and fan-room floors, ventilation ducts around the auditorium, supports for marble beams and backing between marble column capitals, supports for the barrel-vault corridor ceiling of the first story, auxiliary supports for the groined-arch ceilings of the entrance, backing for ornamental iron, framing for the ceiling of the auditorium, for the front court parapets, for the glass and plaster vaulted roof of the entrance lobby and for window cleaners' walkway under the skylight, framing for storage distribution walkways over the show rooms, and finally framing for the first-story ceilings. The latter was designed for a total load of 50 lb. per sq.ft. to permit this space to be used for storage of awnings and other appurtenances. The mezzanine frame consists almost entirely of light structural members, and probably required more attention than the frame of any other tier, on account of the diversity of requirements to be met and the various levels of the framing.

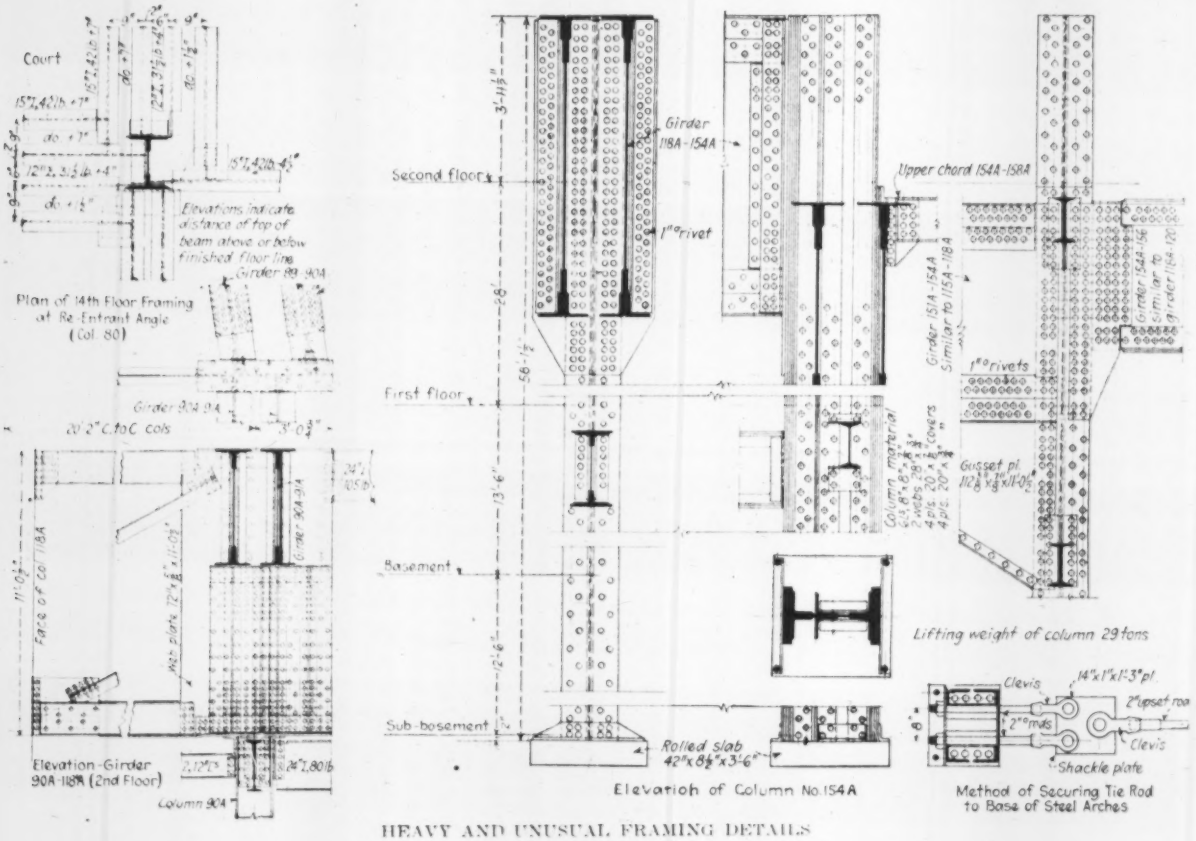
In the second floor there is a considerable amount of



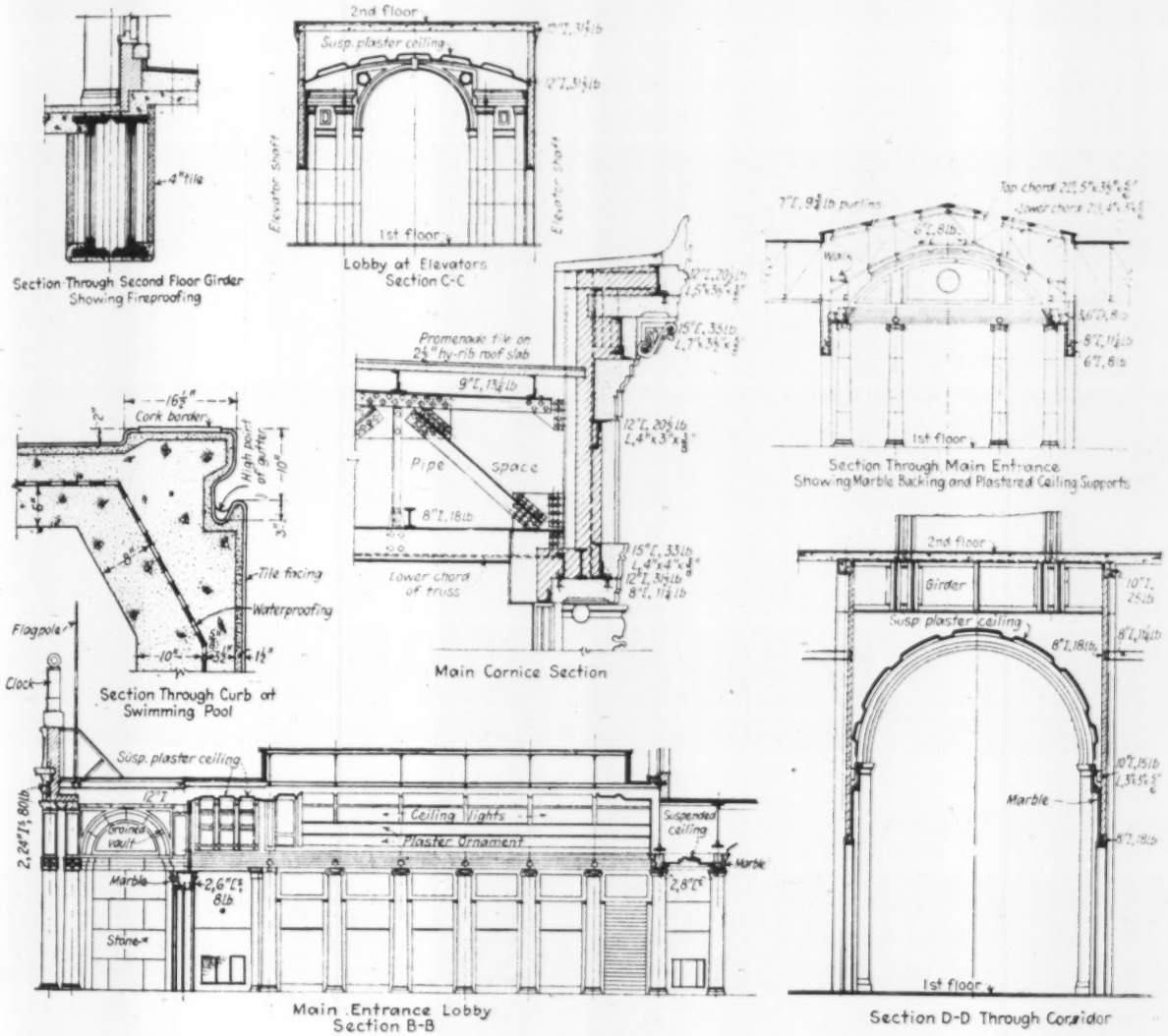
HEAVY SECOND FLOOR GIRDER CARRYING COLUMNS

heavy framing and some long-span girders and trusses. In order to have large unobstructed areas for the first floor show rooms and the auditorium, many columns are stopped at the second floor, and supported on girders attached to adjacent columns. The roofs of courts 6 and 8 are supported each by three trusses of about 100 ft. span. These trusses are of ordinary construction. Girders 80-90A and others similarly placed in other wings have a special connection, illustrated herewith for column 90A. This connection is necessary on account of the skew of the girder, which is required by the alignment of columns 89-90A and the position of upper column 90 carried by the girder.

The large plate girders run from 6 ft. to 11 ft. in



HEAVY AND UNUSUAL FRAMING DETAILS



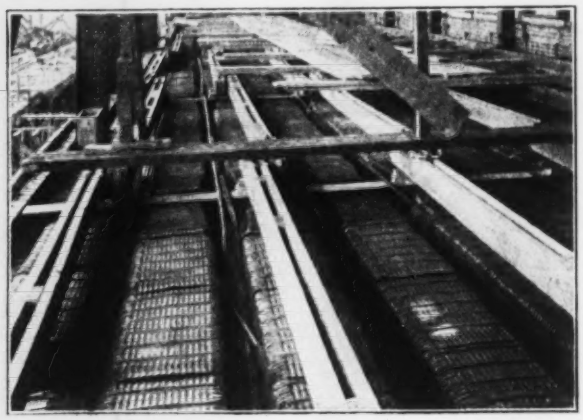
FIREPROOFING AND MASONRY DETAILS

depth. Some support the second floor on their top flange and the mezzanine frame near the bottom, but in most cases headroom is required for the mezzanine, so that the shallower girders are in preponderance.

The auditorium roof is supported by trusses of 45 ft. span, carrying on their top chord the skylight purlins and near the bottom chord the ceiling purlins. The truss verticals support the tracks for the window-cleaning movable bridges in each bay. These trusses are supported on their north end by girder 115A-151A, about 100 ft. span, provided with a horizontal bracing system to stay the top chord. The south end of the trusses is supported by girder 118A-154A. This girder has a span of nearly 100 ft., and is the heaviest member in the structure, weighing 100 tons. In addition to the auditorium roof trusses it carries the north wall and a part of the floors and roof of an extension of the main building between the two intermediate rear wings; this extension, four stories high, is situated entirely above the auditorium roof. The girder consists of two connected units of 50 tons each, erected separately, and each made up of a web plate 102 x $\frac{3}{4}$ in., four flange angles 8 x 8 x 1$\frac{1}{8}$ in., four flange plates 16 x $\frac{5}{8}$ in., and eight cover plates 18 x $\frac{5}{8}$ in. Its calculated load, including girder and fireproofing, is 1,648,000 lb. As the top of the girder is above the beams which steady its top flange, gusset-plate braces were connected to the beams, butted tightly, and riveted to the girder.

From the third floor to the fourteenth inclusive, the live load used was 50 lb. The frame consists of single or double I-beams or built-up plate girders in general 18 in. deep, connected directly to the columns, placed transversely of the wings or transept, and supporting the concrete floor construction. The interior columns are tied together longitudinally by 10-in. channels framed to the columns with seat and top angle connections, or, where required not to show in the ceiling below, by pairs of 5 x 3½-in. angles, Z-shape, connected like the channels.

The differences which occur in the framing from the third to the fourteenth floors occur chiefly in the spandrel sections. At the fourteenth floor the upper colonnade is supported by three I-beams framing to the wall columns. These beams are placed so that the load which each one carries will cause an equal deflection in each beam. The multiplicity of fourteenth floor spandrel beams gave rise to an interesting detail at the re-entrant corners, such as the one illustrated for column 80;



SHALLOW METAL TILE USED TO CORE OUT 7-INCH LONG-SPAN CONCRETE FLOOR

eleven beams, practically at one level, are all framed to the one column.

The fifteenth floor is laid out on the same lines as the floors below, but the standard 18-in. depth of framing is changed to 20-in. to support the assumed live load of 80 lb., chosen because of the large dining and club rooms to which this floor is devoted. The spandrel consists of an 8½-in. brick wall backing an ornamental cast-iron fascia. It is supported by a single beam surrounded by a horizontal channel to stiffen the wall. This channel is strutted up from the spandrel beam. On account of the deep reveal of the colonnade, the spandrel beams are 33 in. inside of the building line and frame to the transverse floor beams, not to the columns.

The pipe-space floor and roof are carried in general by 50-ft. Warren trusses across the wings or transept. The bottom chord of these trusses is made of channels, as the pipe-space frame which it supports does not usually strike panel points. The roof purlins are carried on the top chord. A section showing one of these trusses and the main cornice framing is given herewith.

No great amount of wind bracing was considered necessary for the building. As the northwest and southwest winds attain great velocity at times in this locality, the outer ends of the wings, which are 52 ft. wide, were assumed to resist wind pressure for one-half of the length of the wing. From the stresses found were deducted the calculated capacity of wind resistance of the interior transverse bents in the half wing considered, these interior bents being framed to the columns with seats and top angle connections. The balance of the stresses was readily taken care of by beams only one or two sizes greater than that required for spandrel loads only, and properly connected to the columns by wing plates of ordinary construction.

In general, the columns are I-shaped, made up of a single web with angles and cover plates. The first tier of columns rests on steel billets and I-beam grillages directly on the concrete footings. The length of most of the columns in this tier varies from 47 to 58 ft. Because of the many upper columns supported by plate girders at the second floor, a considerable number of first-tier columns receive calculated loads ranging from 1,500,000 to 2,500,000 lb.

The only special column sections are columns 118A and 154A, extending from the footings to the top of girder 118A-154A, previously mentioned. Column 118A receives heavy beams and a 26-in. plate girder at the first floor. At the second floor it carries single-web girder 90A-118A, illustrated on p. 628; girder 118A-120, a double-web member some 55 in. deep, girder 115A-118A, a double web plate girder about 11 ft. deep, and the 100-ft. girder 118A-154A, already mentioned. The combined second-floor reaction is 2,854,000 lb., and the load below the first floor is 3,000,000 lb. The section, chosen largely because of the requirements for second-floor connections, consists of one web 29 x ½ in., six angles 8 x 8 x ¾ in., two cover plates 20 x 2¾ in.

Column 154A is similar to column 118A just mentioned, and has a length of 58 ft. This is the heaviest column in the building, weighing 29 tons.

Concrete Floors and Fireproofing

The reinforced-concrete floors span directly from one column bent to the next, parallel with the long axis of the wings and transept. They consist of concrete slabs from 6½ to 7½ in. thick, hollowed out by metal tile 5 in. deep and about 20 in. wide, made especially for this building. At the spandrel supports the slabs are fixed in place by anchors running through the web of the spandrel beams. The top of all slabs is placed 1½ in. above the top of the supporting beams. The slab is topped by 3 in. of slag concrete, in which are embedded the majority of the conduits. Where too many conduits would have intersected, some of them were placed on the reinforcing steel before placing the metal tiles, which were clipped to fit. The steel beams are fireproofed not with concrete, but with ordinary shoe tile surmounted by a block of partition tile, which forms the bearing for the concrete slab. Except for the second floor, this tile was not filled with mortar, as actual tests show that tile will carry a live load of some 250 to 300 lb. per sq.ft. without difficulty on 18-ft. spans.

The centering for the concrete slabs consisted of units, supporting each joint, carried by pairs of 2 x 6's spaced about 6 ft. apart. The 2 x 6's were hung by bolts from pairs of 2 x 8's, blocked up at each end from the steel beams of girders supporting the concrete floor after it had set. In some cases one row of shores was used instead of intermediate hangers. The forms were readily removed after the slab had hardened, and were re-used for the floors above.

The large second-floor girders are fireproofed with partition-tile walls projecting beyond the stiffener angles, and blocked against the girder webs. These walls are supported on a concrete casing poured around the bottom flange of the girders. All steel columns are fireproofed with hollow tile, except below the first floor, where they are cased in concrete.

Two blocks south is the power house, 100 x 100 ft. part of the project. It was built simultaneously with the main structure, to which it is connected directly by an 8 x 11½-ft. tunnel 275 ft. long, through which the heating lines and the power and light wires are brought.

The General Motors Building and power house were erected by the Thompson-Starrett Co., under the general supervision of the architect's superintendent, R. A. Denell. The steelwork was fabricated by the American Bridge Co. at its plants in Ambridge, Canton, Toledo, Detroit and Chicago (Lassig), and was detailed under the personal supervision of George E. Poucher at the Ambridge plant. The architectural, mechanical and construction plans and specifications were prepared by the several departments of the office of the architect, Albert Kahn, of Detroit.

Some Practical Details of the Railway Wage Regulations

IN ORDER for each reader to judge for himself of the possible effect of current agreements in railroad circles upon labor other than that employed by the railroads, a few of the more pertinent incidents brought out in testimony presented to the Railroad Labor Board at recent hearings in Chicago, are given in the following paragraphs. The testimony was given by various railroad executives in support of their contention that national agreements, rules and working conditions, put into effect during the latter months of government control, should be abrogated. The material herein set forth is taken from various bulletins issued from the office of the Association of Railway Executives, New York City.

Operation of Regulations

As illustrative of the operation of Rule 7, which provides that "for continuous service after regular working hours, employees will be paid one hour for forty minutes service or less . . . employees required to return to work will be allowed five hours for three hours and twenty minutes service, or less," a case was cited in which six men composing a gang completing repairs of an engine in shops of the Chicago, St. Paul, Minneapolis & Omaha R.R., were each paid five hour wages for one half hour's work. There was no interruption in work, but the extra half hour was claimed and allowed to be an additional shift. The circumstances of the case were, that at the close of the regular working day, the testing of the engine on which the six men were working had not been completed. A leak developed which made it necessary for the gang testing the engine to work thirty minutes past the ninth hour of their employment. It was decided that this thirty minutes work entitled each of the men employed on this job to five hours wages.

Another angle of Rule 7 is set forth in the following circumstance explained at the Labor Board hearing. A machinist, used to relieve an engine-house foreman, and employed by the Michigan Central R.R., received pay for 19½ hours, although he gave only 11 hours service. The inexperienced substitute got $16.57 for a day's work, as compared to $10.66 received by the regular forman for the same day's work. The rule here applying is given in the records of the Labor Board hearing as follows: A machinist used to relieve an engine house foreman must work the same number of hours as the foreman whose place he is filling. The regular time of the machinist is from 8 a.m. to 4 p.m., and the regular time of the foreman is from 7 a.m. to 6 p.m.

Illustrating Rules 157 and 158, which provide respectively, that "wrecking crews, including engineers and firemen, shall be composed of regularly assigned carmen, and will be paid for such service as per general rules, from time called until return to their home stations"; and "when wrecking crews are called for wrecks or derailment outside of yard limits, the regularly assigned crew will accompany outfit," a case was cited in which a railroad was compelled to award each man in a wrecking crew 13 hours pay during which time no actual service was performed. At regular and overtime rates the men received 37½ hours pay for service all performed within 24 hours. Of the 24 hours for which they received 37½ hour's wages, the men were off duty or asleep for 11 hours, and were riding or eating for 2 hours while receiving pay. Under a related rule claims are constantly made by men who do not actually accompany the crews, but assert that according to the rules they should have done so and therefore are entitled to pay.

Further testimony before the Railroad Labor Board indicated that three employees of the Marquette R.R. received back pay totaling $9,333 merely because their titles were changed from pumpers to electricians. For the same reason, they received an increase in pay, although they continued to perform precisely the same work. The circumstances of the case, as stated in the records of the Labor Board hearing are as follows:

Before Nov. 4, 1918, two attendants were employed at a small power plant at Baldwin, Mich. They were paid at the rate of $84 and $60 per month. On the date stated, a third man was employed to be put to work on an 8-hour shift, the pay being increased to $90 for one man and $80 for the other two. These men had always been classed as pumpers and had no knowledge of electrical matters prior to their employment at this point; they could not qualify as electricians for any work except as attendants at this particular station. Their principal duties were to keep the machinery oiled, start and stop waterwheels and watch that no breakdown occurred.

Under Rule 141 of the shop-craft agreements, these men claimed to be entitled to pay as motor and generator substation attendants and switchboard operators. The decision rendered by the director general of railroads not only awarded back pay, but fixed the compensation of these men in the future at the rate of 72c. per hour for one man and 68c. per hour for the other two men, making the total to be paid for their services more than the value of the water pumped and current generated.

Hourly Pay and Decreased Efficiency

Various executives were present before the Railroad Labor Board in Chicago to testify that, from personal observation, the efficiency and output of car repairmen had been materially impaired through the abolition of piece work and the substitution therefor of a guaranteed hourly rate.

R. L. Kleine, assistant chief of motive power, Pennsylvania R.R., submitted exhibits showing that in less than a month after the guarantee-pay system went into effect the efficiency of the men in terms of output per hour decreased 11.6 per cent. W. I. Langford, of the Union Pacific R.R., presented further evidence in the endeavor to prove the contention that the substitution of the hourly basis of pay for piece work had greatly decreased shop output. Instances cited were as follows:

Time required to perform work in the blacksmith shop at Omaha increased 35.5 per cent, and the output was reduced 26.2 per cent. In the wheel shop at Omaha the time required for the same work was increased 31.9 per cent and the output was cut down to 24.2 per cent. In the wheel shop at Denver, Colo., the time required to perform the same amount of work increased 40.5 per cent; the output fell 28.8 per cent. The time required for certain work in the paint shop at Omaha increased 42.4 per cent and the ouput decreased 29.8 per cent.

Similar testimony was given by representatives of the Union Pacific R.R., of the Chesapeake & Ohio R.R. and other railroads.

Alaska Railroad Location Surveys Through Broad Pass

Leating in Sixty-Mile Gap in Existing Line—Methods and Troubles—Organization, Equipment and Camp Outfit

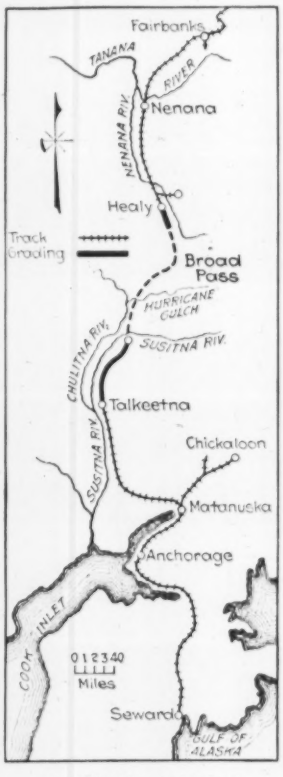
By T. W. Secrist
Location Engineer, Alaskan Government Railroad

Between the operated southern and northern divisions of the Alaska Railroad, which is being built for the United States Government by the Alaskan Engineering Commission, is an uncompleted stretch of about 100 miles which is partly under construction (see "Engineering News-Record," Jan. 2, 1919, p. 46). This stretch includes the Broad Pass district, where the line will reach its highest elevation and where the location surveys have been made only recently. Col. Frederic Mears is chairman and chief engineer of the Commission.—Editor.

A ROAD PASS DISTRICT on the route of the Alaskan Government Railroad comprises the region lying between Indian River (mile 266) and Jack River (mile 327). It includes not only Broad Pass, which is the main divide between the coast and interior of Alaska, but also Chulitna Pass, which is a minor grade summit between the Susitna and Chulitna rivers. Broad Pass proper is nearly eight miles wide, and for five miles the railroad will be practically level. The highest elevation attained is 2,362 ft. above mean sea level. The principal topographical features are high mountains on the east and west sides of the pass, rolling low ridges, some of which are timbered and others are covered with heavy arctic and reindeer moss, numerous lakes and much swampy ground or muskeg.

Route—After crossing the Susitna River (mile 264) the line follows up the Indian River canyon and traverses Chulitna Pass (mile 274), leaving Indian River to the east. Thence it climbs on a compensated maximum grade of 1.75 per cent to the high benches east of the Chulitna River and (at mile 284) crosses Hurricane Gulch, which is a canyon 300 ft. deep and over 600 ft. wide. Then the line descends on a grade of 1.50 per cent to the Chulitna River bottoms, which it traverses to the crossing of the East Fork of the Chulitna River (mile 292) and then climbs on a 1.75 per cent grade to the high rolling bench lying between the East Fork and Middle Fork of the Chulitna, crossing the latter fork at mile 306. Thence the line climbs on a 1 per cent grade to Broad Pass summit (mile 310) and descends northward on a 1 per cent grade, crossing the Cantwell River (mile 317) and Windy Creek (mile 323) and following down the Jack River to its confluence with the Nenana River (mile 327).

The south approach to Broad Pass offered several different routes which were fully developed before a line was finally adopted, the region around Hurricane Gulch being especially difficult. This gulch will be crossed by a steel bridge 700 ft. long and some 300 ft. high, with a main arch span of 284 ft. Four separate location lines were run and comparative estimates of cost were made over a section of about ten miles of heavy work involving different crossings of the gulch, before a choice was made from the lines. Before making a final selection, careful estimates of cost were worked up and compared, but greater stress was laid on the maintenance and operating features of the lines.



ALASKAN RAILROAD

From June 1 to Oct. 1 is the working season for survey parties, so that as the country was without roads or trails of any kind and was practically unexplored, it took several seasons to develop the region thoroughly. A locating party consisted usually of a locating engineer, assistant engineer, transitman, topographer, levelman, draftsman, office man, two rodmen, four chainmen, one rear flagman, two cooks, ten axemen, four packers, one hunter, and a pioneer crew of about six men to build trails.

Transportation — From Indian River (mile 266) transportation was by pack train, some 36 head of horses and mules and four packers being required for this purpose. Horses were loaded with about 200 lb. of supplies, and pack trains made from ten to twelve miles per day. Each animal was fed 10 lb. of oats per day. At night they foraged on the native grass, which is very nutritious until the frost kills it in September. The trails were usually very heavy on account of the swampy country, and considerable difficulty was experienced in fording the numerous rivers and creeks during the high water from the heavy rains.

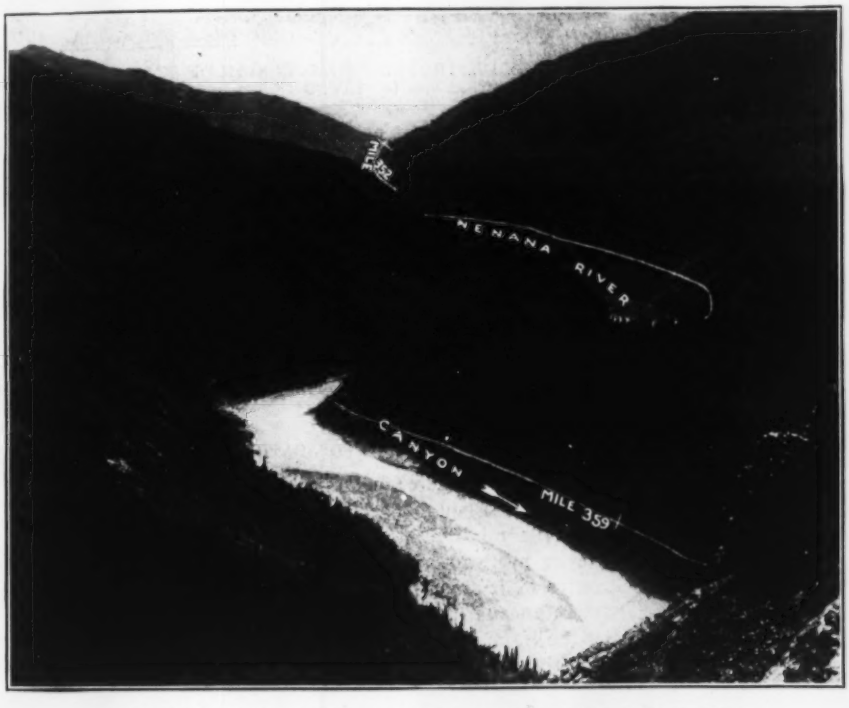
The pack rigging consisted of saw-buck pack saddles with Humboldt rigging and alforgas, or pack boxes with canvas covering, were used in which to put the small articles. Horses were troubled a great deal by mosquitoes and flies. Various fly ointments were used, but the best results were obtained by greasing around the ears, eyes and nostrils of the animals, and building "smudges" so they could stand in the smoke when they were not grazing.

Equipment and Subsistence

Under these conditions, the equipment of the party and the personal effects of the men were held down to absolute necessities. The cooking outfit comprised a 16 x 24-ft. dining tent and a 14 x 16-ft. cook tent, both of 12-oz. canvas and with 4-ft. walls, granite-ware cooking utensils and dishes and two sheet-iron stoves weighing 125 lb. each. For the office there was a 14 x 16-ft. tent, a knock-down drafting board, a Sibley stove and two stationary chests of a size to balance on a pack horse. Mosquito tents 9 ft. square with 3-ft. walls were used for sleeping quarters. A mosquito tent is a lightweight duck or silk tent with cloth floor and a drawstring cloth door. Three men were assigned to a tent and camp fires were depended upon for warmth and for drying out.

Baggage and Clothing—Each man was limited to 50 lb. of bed and baggage. Ordinary blankets with a canvas

tarpaulin were used, and spruce boughs made splendid mattresses. Clothing consisted of hunting shoes, rubber shoe packs, khaki and mackinaw coats and trousers, wool underclothing, wool sox and gloves, and mosquito head nets. Mosquitoes and different species of gnats and flies were a great pest. They carry no disease germs, but are exceedingly energetic and annoying. Mosquito head nets and gloves were the best protection, although each man had some pet mosquito preparation, composed of different proportions of oil of citronella, peppermint and wintergreen, but in most instances the scorched faces and awful odor of the remedy were as bad as the mosquitoes.



NENANA RIVER VALLEY ON ALASKA RAILROAD LOCATION

Subsistence consisted almost entirely of the ordinary staples of flour, ham, bacon, rice, sugar, dried fruit, dehydro potatoes, canned and powdered milk, evaporated eggs and some canned fruits. A limited quantity of fresh eggs and fresh potatoes was packed as far as seventy miles. A hunter and two pack horses kept the party fairly well supplied with bear, caribou and mountain sheep, and as the streams abound in greyling and trout there were many messes of fish. In August and September the blueberries were plentiful, so blueberry pies were almost a daily feature.

Instrument equipment was of the ordinary character, with vertical-arc transits reading to thirty seconds and wye levels with target rods reading to thousandths of a foot. Steel tapes 50 ft. long, steel marking pins, hand levels and 24-oz. plumb bobs were used for chaining the line.

Reconnaissance of route was made by the locating engineer and the preliminary lines were run by him as closely as possible to where he thought the location should go. An accurate preliminary line was run. Hand levels and plumb bobs were used in chaining, and all angles were doubled and back sights set in transit work. The leveler took elevations at every 50-ft. station and at intermediate breaks as necessary to show a correct profile of the ground. On turning points and bench marks the readings were to thousandths of a foot. The topographer followed on preliminary with a rodman, two chainmen and one axeman. Actual 5- and 10-ft. contours and slope notes were taken, but in most places a few side notes and additional information on controlling points was sufficient.

Topography—No attempt was made to make an elaborate topographical map of the country. As the located line usually held very close to the carefully run preliminary, accurate local topography within a short distance of the preliminary line was all that was needed. On location the topographer plotted the line and in the field amplified the accurate topography by sketching in the general topography of the country. An aneroid barometer was used for approximating the elevations, prismatic compass and foot traverses being used for the direction and distances.

On the located line well-made stakes were placed at 50-ft. intervals, substantial hubs being set at every curve point and as often as necessary on tangents. Bench marks with the elevations marked upon them were set at about half-mile intervals. All curves from two degrees to the ten-degree maximum were spiralled with the Southern Pacific Railway's system of taper curve. In plotting the line, a scale of 100 ft. to the inch was used, except in short sections of light work where a scale of 400 ft. to the inch was used. Co-ordinates were used in the mapping, and the projected location was figured by independent traverse, a check being made through the map co-ordinates.

Mapping—The draftsman made all the maps and kept a traverse book of the courses of the preliminary and located lines. He was checked in the computation of the map co-ordinates by the office man. Profiles were plotted on profile paper, and it was the duty of the office man to keep up the profiles. The profile of the line of definite location showed the alignment, hub points, rates of grade, grade points, location and elevation of bench marks, side slopes of the ground, timber notes, and classification and vegetation notes.

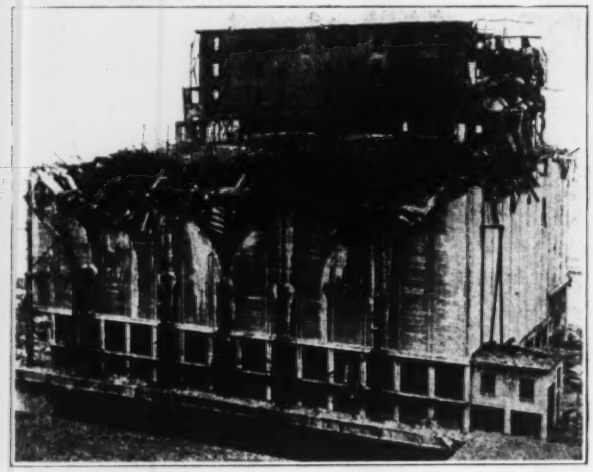
As the topography of the country was quite rugged in places and the whole area was covered with a fairly dense growth of spruce, birch and cottonwood trees, besides a heavy undergrowth of willow and alder brush, the progress of the party depended a great deal on the axemen. About two-thirds of the days were rainy, which made the work progress slowly, although work was done every day except Sunday, whether it was in rain, sunshine or snow. Preliminary lines and levels varied from 2,000 ft. to two miles per day, and location lines and levels from 1,500 ft. to one mile per day.

Dust Explosions: Cause, Effect and Prevention

Structural Design and Mechanical Equipment Needed to Check Loss of Life and Immense Loss of Property

By David J. Price
Engineer in Charge Development Work, Bureau of Chemistry, U. S. Department of Agriculture

MANY engineering problems have been developed in the study of dust explosions, their causes and prevention. Before these explosions can be prevented, it is necessary to determine the various causes and circumstances under which dusts can be ignited, the manner in which the explosion spreads or propagates, the ignition temperature of the various dusts, the pressures developed and also the effectiveness of any methods which may be designed for prevention. Dust explosions have occurred most frequently in plants



GRAIN ELEVATOR DAMAGED BY DUST EXPLOSION

where grain or grain products are milled or handled, such as grain elevators, flour mills, feed and cereal mills, and starch factories. They have occurred also in sugar refineries, cocoa and chocolate plants, candy factories, spice works, wood working establishments, paper mills and printing plants, shoe factories, fertilizer works, cork grinding plants, drug and herb works, and other industrial plants where dusts are created. Explosions of aluminum and magnesium dusts have also taken place. Many disastrous smut and grain dust explosions have occurred in threshing machines in the Pacific northwest, while a large number of fires have occurred in cotton gins during the ginning process.

Since May 1919, several disastrous explosions have occurred in the United States and Canada, resulting in the death of over 94 people, injury to a large number and property damage in excess of $10,000,000. Four occurred in grain elevators, two in flour mills, one in a feed mill and one in a starch factory, this last resulting in 43 deaths and over $3,000,000 damage. In three grain elevator explosions, 14 lives were lost in the first, ten in the second and six in the third, all explosions being violent and doing extensive damage. In an explosion of aluminum dust six girls lost their lives and as many more were injured. An explosion of hard rubber dust resulted in the death of eight workmen.

FACTORY DESTROYED BY EXPLOSION OF STARCH DUST (43 LIVES LOST)

The disastrous explosion on March 19 in the Chicago and Northwestern Elevator operated by the Armour Grain Co. at South Chicago has attracted the attention of engineers of the United States and Canada. (See *Engineering News-Record*, March 31, 1921, p. 560.) The elevator, which has a capacity of 10,000,000 bushels, was built entirely of fire resistive materials and embodied the latest modern engineering principles. The explosion, which caused the loss of six lives and property and grain damage in excess of $3,000,000, has been fully investigated by the Bureau of Chemistry and will be reviewed in a later article.

Ignition and Propagation of Flame

A dust explosion appears to be very similar to a gas explosion, although particles in a dust cloud are larger than the minute molecules in a gas. Both require a proper mixture of air and ignition by some external source of heat or flame, it being impossible to produce "spontaneous" explosion. In the study of dust explosions by the U. S. Bureau of Chemistry ignition temperatures resulting in propagation were determined as follows: 2,363 deg. F. for wheat elevator dust, 2,300 deg. for flour, 1,821 deg. for oat and and corn elevator dust, 1,868 deg. for oat hull dust and 1,877 deg. for yellow corn dust.

Two theories are prominent in explanations of the action that takes place during the progress of dust explosions; (1) That a distillation of flammable gases occurs when the dust becomes heated; (2) that the explosion is nothing more than a rapid communication of flame or fire from one particle to another, depending to a large degree on the fineness of the dust. That is, the finer the dust and the lower the moisture content the more rapid the propagation and the greater the violence of explosion. This seems to establish very definitely a relation between fire and explosion.

In many cases a primary explosion, which is nothing more than a small puff, is followed by fire in which the property is extensively damaged or destroyed. In other cases a series of increasingly violent explosions follows, indicating that if dust is present to feed the original flame an explosion will follow. In plants where little dust is in suspension and where "good housekeeping" is practiced, the occurrence merely assumes the proportions of a fire and no violent explosion results. Reference is made to this phenomenon to emphasize the fact that a disastrous dust explosion may occur during the course of any fire if sufficient combustible dust is present to feed the flame and allow it to propagate. The dust that accumulates throughout the plant is thrown into suspension by slight concussion, with the

result that a primary "ignition" or explosion develops into a secondary explosion of large proportions.

The rate of propagation or flame travel in a dust explosion depends upon the flammability of the dust and the amount of it in suspension. Reports of the U. S. Bureau of Mines give the average velocity of flame in coal dust explosions as 2,270 ft. per second; British and French investigators report 2,114 and 3,300 ft. per second respectively. The velocity is usually more rapid in gas mixtures than through dust clouds. Limited tests indicate that the velocity through a cloud of wheat-flour dust is practically the same as through coal dust and that through a cloud of powdered starch it is several times as rapid as through coal dust.

Tests conducted on a large scale by the Bureau of Mines show a pressure of 103 lb. per square inch with coal dust. British investigators report from 100 to 120 lb. A French investigator reporting 227 to 270 lb. states that at a steel testing gallery with an estimated breaking strength of 570 lb. per square inch the gallery gave way and pieces of sheet steel were thrown up a distance of 472 ft. From extensive laboratory tests by the Bureau of Mines and the Bureau of Chemistry, based on only 75 mg. of dust in standard laboratory apparatus, the results shown in the accompanying table have been obtained.

The values shown there are much smaller than those obtained in full sized tests but interesting as a comparison of the behavior of different materials. That grain dusts are more flammable than coal dust is confirmed by tests on a large scale. In recent tests conducted in co-operation with the Bureau of Mines in its testing galleries it was found that flour and coal dusts acted similarly. Starch dust propagated more rapidly, produced higher pressures.

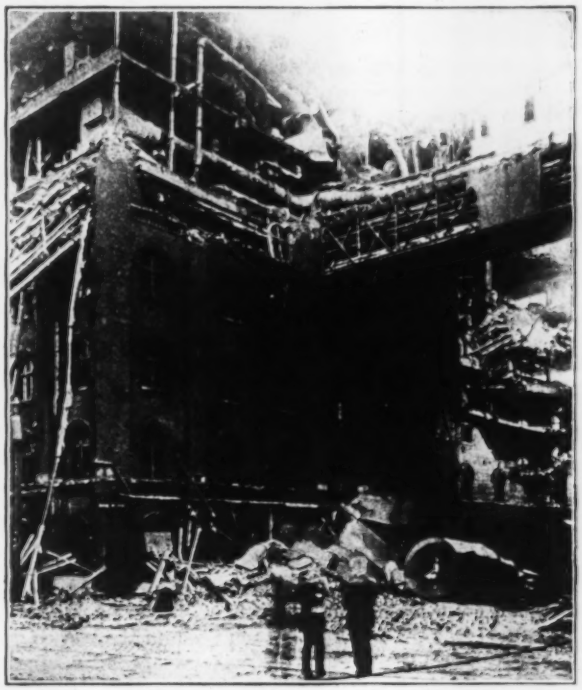
Dust	Lb. per Sq.In.	Dust	Lb. per Sq.In.
Lycopodium	17 5	Sugar	12 2
Wheat smut dust	15 9	Potato flour	11 7
Yellow corn	15 2	Fertilizer	10 5
Dextrine	14 6	Coal (Pittsburgh)	10 1
Tan bark	13 3	Cocoa	9 1
Wheat elevator dust	13 0	Sulphur	8 8
Wood dust	12 8	Cork	7 4
Corn starch	12 7		

Efforts are being made to establish proportions of dust in suspension necessary for an explosion. Laboratory tests indicate that only 10 lb. of dust in suspension would be needed in a closed room containing 4,466 cu.ft., or a room 10 x 30 x 15 ft.

The first dust explosion to attract attention in this country occurred at Minneapolis in 1878. Professors Peck and Peckham, of the University of Minnesota, in experimental work for the investigation which followed the explosion, found that by blowing 2 ounces of dust upon an open flame in a box containing 2 cu.ft. of air, sufficient pressure was developed to lift two men standing on the cover. This would mean diffusion at the rate of one ounce of dust to 1 cu.ft. of air space. From the known chemical composition of flour and a calculation of the approximate mechanical work which a given mass of flour can perform, it has been found that the contents of an ordinary sack, when mixed with 4,000 cu.ft. of air, will generate force enough to throw 2,500 tons mass to a height of 100 ft.

The relation of humidity to the frequency of dust explosions has been markedly noticeable in the investigational work. This is especially true of explosions where static electricity has appeared as a probable cause. Although this relation has not been definitely determined in industrial plants, it is reasonable to conclude that the dust explosion hazard is greater during periods of continued low humidity.

A close relation between the construction of a plant and the extent of an explosion within it has been developed by the investigation of a number of disastrous dust explosions in grain handling plants, especially in the large terminal grain elevators. This was considered at a conference of men engaged in a grain dust explosion and fire prevention campaign, conducted by the U. S. Grain Corporation in co-operation with



REFINERY WRECKED BY EXPLOSION OF SUGAR DUST
(12 LIVES LOST)

the Bureau of Chemistry, U. S. Department of Agriculture (see *Proceedings* of the U. S. Grain Corporation, July 1, 1920).

The following matter refers to the possible changes in construction and in the installation of mechanical equipment suggested by recent explosions and their relation to dust explosion prevention. Common sources of ignition, such as matches, torches, lanterns and similar open flames have been accepted for some time, but recent investigations have associated certain types of mechanical equipment with the cause of the explosion. Explosions have been caused apparently by metallic sparks produced in dust collecting fans and in various types of grinding machinery. Broken incandescent lamp bulbs in dusty atmospheres, dust settling on the bulbs and sparks from static electric discharges produced by the operation of various types of machinery have also been responsible for the ignition of flammable dust clouds.

Dust collecting equipment is one of the effective methods of controlling explosions, as an accumulation of dust throughout the plant permits the propagation of flame from the time of the original ignition until the secondary or larger explosion occurs. But a number of

explosions have been directly associated with the manner in which the exhaust fan was installed. A disastrous explosion of aluminum dust was caused by a piece of wire entering the fan.

Exhaust fans are installed frequently in connection with the removal of dust from buffing or polishing wheels, grinding rolls and similar equipment. In such cases the fine dust is drawn usually from the source of production through pipe trunkings into the fan and then blown into the collecting device. As a flammable mixture is usually formed in the exhaust fan, explosions may originate from the ignition of the dust by sparks from foreign material striking the fan blades, or from loose blades striking each other or the casing. This has suggested the practicability of placing the fan beyond the collecting device, so that the dust will be drawn through rather than blown into the collector. The Industrial Commission of Wisconsin, co-operating with the U. S. Department of Agriculture, has designed a system of primary and secondary air currents for dust removal, which has recently been installed in a factory, and investigation made as to its practicability.

Changes in Construction

Walls, Windows and Doors—To prevent high pressures from being built up within heavy concrete wall construction, consideration might be given to the use of a thin wall offering little resistance to the great volume of gases produced by the ignition of the dust. In such a building all the working stresses would be placed upon the concrete columns and beams, the walls serving only as a filler or curtain. Large window area, or the daylight type of building construction, affords another means of preventing high interior pressures. Recent explosions in two different lines of industry were localized as a result of this type of construction. Windows of the steel sash type, self supporting and extending from the ceiling to the floor, would be preferable. Steel curtain doors have been used on the working floors of grain elevators. They can be opened during the day, providing good ventilation to the working floor and a vent for any explosion on this floor.

Bin Construction—A recent dust explosion occurred in a large grain elevator having the sides of the steel bins formed in horizontal trough or corrugations, this construction being claimed to strengthen the bins. Each corrugation was 8 in. deep with a vertical side 8 in. high and top and bottom sloping at 41 deg. from the horizontal, the corrugations being 15 in. c. to c. The intensity and extent of the explosion was increased apparently on account of the large amount of dust accumulated on the inclined plates. Although this type of construction may have its advantages, it is hazardous from a dust explosion standpoint. Smooth sides on which dust could not collect would be safer.

Explosions have propagated over extensive areas and assumed large proportions when grain storage bins were connected by open air spaces. Where the bins are extended and the bin floor is placed directly on top of them, so that each one is isolated, the extent of the explosion is usually limited. Ventilation of the bins, which is necessary at the time of filling and emptying, may be provided by perforated iron covers or grids for the manholes. If this is not sufficient, ventilators may be led from each bin through the wall or roof.

Vents and Lofters—To keep an industrial plant clean, it is necessary to make provision to remove the dust at points where it is created. If regulations will not permit of such a dust removing and collecting system as in grain elevators (owing to apparent loss in weight of grain), consideration might be given to extending the head of the lofters through the roof, capping them so as to keep out the storms but to allow for ample ventilation. Where this is not advisable, some type of vent from the head of the lofter to the outside would be beneficial in removing the dust from the grain and keeping the elevator clean.

If suction or draft cannot be placed on elevator legs and bins, it is desirable to provide natural vents. Scale hoppers and garners especially should be vented to the outside, for the reason that when grain is run into a scale hopper the dust-laden air in the hopper is forced out and will enter the elevator building unless the hopper has vent.

The intensity of the primary or original explosion in some instances has been due in part to the size of the chamber in which the explosion occurred and partly to the amount of dust present. This has been demonstrated clearly when large lofter wells are installed in grain elevators. If the lofter is of the continuous double leg type instead of having the large lofter well, the chamber is much smaller. With a completely double legged lofter or even with a well having smooth sides, the extent of the explosion would be limited. Steel elevator legs from the boots to the head are more desirable than the combination steel and tile leg bins, as they prevent the accumulations of dust that are usually found in tile or concrete leg bins.

Friction of pulleys and belts at the head of elevator legs has continued for a period sufficiently long to cause the belt to burn and weaken, with the result that it parted and fell to the bottom of the leg. It is possible that the explosion caused by the ignition of dust by the flame from the smoldering belt, might have been prevented by some device for extinguishing the fire. Automatic sprinklers have proved effective for incipient fires of this nature and with sprinklers in the heads of the lofters the explosion might be controlled.

From investigation of explosions in grain elevators attributed to the rubbing of belts and pulleys at the head of elevator legs resulting in "choke-ups," it appears that friction at the head could have been prevented by some provision for shutting off current from the motor operating the elevator leg. A circuit breaker which would be thrown out as soon as there is a definite overload on the motor might be considered.

In some instance "chokes" have occurred in elevator legs due to over-feeding at the boot. If there had been some way of giving warning to the man in the basement who had control of the feeding of the grain, he might have stopped the flow of grain and thereby have prevented the choke. It is suggested that an idler or guide pulley might be employed to make an electrical contact or give some other signal when the belt slows down to a certain speed.

Birmingham Water Contract Extended

The contract between the Birmingham Water Works Co. and the City of Birmingham, Alabama, that expired Dec. 31, 1920, has been extended for 30 years. Under the new contract Birmingham will have the right to purchase the plant at any time at the base valuation of $7,750,000 as of Jan. 1, 1921, while for rate making purposes, the value fixed is $7,000,000 as of Jan. 1, 1920.

Chemical Analyses of Cement as Indicators of Behavior

Rearrangement of Stock Analyses Recommended So as to Show True Content of Active Agents

IN a paper entitled "Judging the Quality of Portland Cement," recently read before the American Institute of Mining and Metallurgical Engineers, R. J. Colony of the Department of Geology, Columbia University, discussed the necessity for additional tests to supplement the standard physical tests for portland cement, and the possible methods which will aid in judging the quality of cement. Mr. Colony states that in his opinion the most promising mode of attack makes use of chemical, mechanical and petrographic

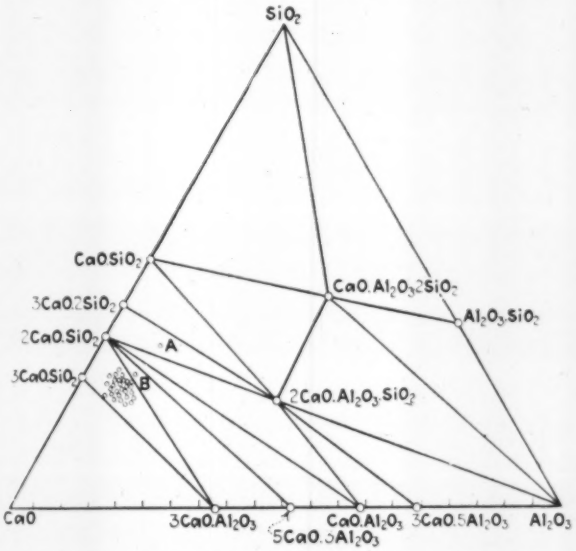


FIG. 1. TRIANGULAR CONCENTRATION DIAGRAM SHOWING END PRODUCTS OF CONSOLIDATION IN PORTAND CEMENT

Normal portlands are restricted to the triangular area bounded by $2CaO.SiO_2$, $3CaO.SiO_2$ and $3CaO.Al_2O_3$. Diagram is after the one used by G. A. Rankin and F. E. Wright in article in *American Journal of Science*, vol. 4, 1915.

methods. He points out that the interpretation of the results of such procedure has already reached a development which permits conclusions of considerable value, and which, in connection with the standard physical tests gives a better basis for the rejection or acceptance of a given cement. The methods, with the conclusions, are summarized in the paper, from which the following extracts are made:

Normal portland cement is composed of mechanical mixtures of definite chemical compounds having constant chemical and physical properties. In the order of their cementing qualities these are: Tricalcium silicate, $3CaO.SiO_2$, tricalcium aluminate, $3CaO.Al_2O_3$, tricalcium ferrite, $3CaO.Fe_2O_3$, and calcium orthosilicate, beta form, $2CaO.SiO_2$. In addition, there is a certain quantity (generally about 3 per cent.) of gypsum. The magnesia, MgO, is in a state of solid solution in the other components and is apparently without much effect in the quantities found in cements. Both potash and soda exist to a small degree, and flakes of quartz from the ball mills, metallic iron from the machinery, particles of semi-fused coal ash from the fuel, etc., are sometimes found.

When mixed with water the components mentioned are hydrated, with the production of amorphous hydrated silicates and aluminates of lime, and a very considerable quantity of calcium hydrate which appears in both crystalline and amorphous forms.

Not all of the components mentioned hydrate with equal ease, since calcium orthosilicate, $2CaO.SiO_2$, resists hydration to a marked degree, persisting in unchanged aggregates in set cement and in concretes, thus decreasing the efficiency of the cement.

Chemical analyses of cement do not give the actual composition of it, since all analyses are reported in terms of oxides, which do not, of course, exist in that form in cements. A comparison of the analyses of two cements throws no light on their actual composition unless the analyses may be converted into percentages of the actual components as they exist; that is, in terms of tricalcium silicate, calcium orthosilicate, etc. It is necessary, therefore, to "recast" the chemical analysis.

As the components of portland cement have a definite composition, the various oxides found by chemical analysis must be uniformly distributed and united with one another according to fixed laws of chemical combination. Hence it should be possible to recast an analysis in much the same manner as rock analyses, and to obtain the percentage composition of the cement in terms of the actual compounds, instead of the oxides of the elements forming the mass. This is accomplished by dividing the percentages of the various oxides by their molecular weights, obtaining thus their molecular numbers, or ratios, and then allotting the proper quantities of silica, alumina, lime, etc., to each in accordance with the various compounds that should form under the conditions of burning. Thus, sufficient lime is allotted to satisfy the requirements of CO_2, Fe_2, SO_3, and Al_2O_3; the remaining lime is allotted to the silica to form both tricalcium silicate and calcium orthosilicate. This should be preceded, however, by a petrographic study of the cement in order to determine whether or not any abnormal components are present. For example, a cement analyzes as follows:

SiO_2, 23.40 per cent.; Fe_2O_3, 3.46 per cent.; Al_2O_3, 5.54 per cent.; CaO, 60.79 per cent; MgO, 2.46 per cent.; H_2O, 2.59 per cent.; SO_3, 1.71 per cent.; CO_2, 0.45 per cent. A "recast" of the analysis will then be as in Table I.

TABLE I. CEMENT ANALYSIS RECAST BY COMPONENTS

			Molecular Ratio	$CaO.CO_2$	$CaO.SO_3$	$3CaO.Fe_2O_3$	$3CaO.Al_2O_3$	$3CaO.SiO_2$	$2CaO.SiO_2$
SiO_2	23.40	÷ 60	0.390					0.049	0.341
Fe_2O_3	3.46	÷ 160	0.021			0.021			
Al_2O_3	5.54	÷ 102	0.054				0.054		
CaO	60.79	÷ 56	1.085	0.010	0.021	0.063	0.162	0.147	0.682
MgO	2.46				in solid solution				
SO_3	1.71	÷ 80	0.021		0.021				
CO_2	0.45	÷ 44	0.010	0.010					

The percentage composition, in terms of the components, may be found by multiplying the molecular numbers allotted (or component constants) by the molecular weights of the compounds; thus, the molecular weight of tricalcium silicate $3CaOSiO_2$, is 228, which, multiplied by the component constant (0.049) gives as a product 11.172, or 11.2 per cent. The componental composition of the cement is thus found to be: Tricalcium silicate, 11.2 per cent.; calcium orthosilicate, 58.7 per cent.; tricalcium aluminate, 14.6 per cent.; tricalcium ferrite, 6.9 per cent.; gypsum, 3.6 per cent.; calcium carbonate, 1.0 per cent.; magnesia, MgO, 2.46 per cent.

It has been established by experiment that the component of greatest cementing value is tricalcium silicate, and the component most difficultly hydratable is calcium orthosilicate. It follows, therefore, that the cementing value of any mixture of these components, such as portland cement, is dependent on the proportions existing between the components, and the fineness of grinding of the mixture. In the example given, as the cement has only 11.2 per cent of tricalcium silicate (the best hydraulic component) and 58.7 per cent of calcium orthosilicate (the most difficultly hydratable component), particularly if relatively coarse, it should be regarded with suspicion.

A long series of studies of the ternary system, lime-silica, alumina, and the system of alumina-silica-magnesia,

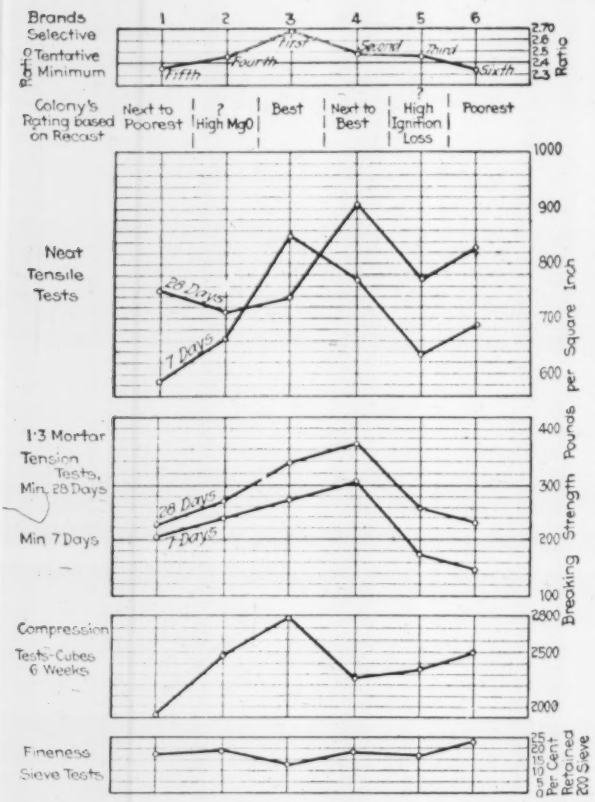


FIG. 2. COMPARATIVE BEHAVIOR OF PORTLAND CEMENTS

as well as studies of binary systems of the same components, by physicists, physical-chemists and chemists of the Geophysical Laboratory, the Bureau of Standards, and different universities, and a comparison study of portland cements has shown quite definitely that the three constituents that form the bulk of normal portland cement—lime, CaO, silica, SiO_2, and alumina, Al_2O_3—exist as fixed components with definite chemical composition and constant optical properties.

A study of the analyses of standard brands of normal portland cement will show that their percentages of lime, silica, and alumina amount to over 90 per cent. Perfectly sound portland cement has been made of these three constituents alone; hence if the percentages of these constituents are recalculated to a basis of 100 per cent, neglecting the ferric and other oxides that are always present in small amounts, the resulting percentages may be plotted on the ternary concentration diagram.

Points thus plotted will fall within a restricted triangular area within the diagram, with three compounds forming the apices of the small triangle; viz., tricalcium silicate, $3CaO.SiO_2$, tricalcium aluminate, $3CaO.Al_2O_3$, and dicalcium silicate (or calcium orthosilicate), $2CaO.SiO_2$, beta modification. Differences in the percentages of lime, silica, and alumina, within certain limits, do not cause the appearance of a fourth and new compound; they merely change the proportion between the three compounds mentioned; this is an important point. If, however, the difference in percentage composition is great enough, on recalculating the percentage of the three constituents (SiO_2, Al_2O_3, CaO) to a 100-per-cent basis and plotting the result, the point will fall outside of the area mentioned and different compounds may be expected to occur, some of which may be non-hydraulic.

The results of about fifty analyses made in the laboratory of the Board of Water Supply of the City of New York have been recalculated and plotted on the accompanying triangular concentration diagram (Fig. 1) in the manner described (some of the dots cover a number of plotted points); all the points so plotted fall within the triangular area mentioned except two, *A* and *B*. One of these *A* is a cement with abnormally high silica (33.01 per cent) and low lime (52.73 per cent); the other *B* falls within the limits of the composition usually set for portland cement, but it also is a little too high in silica and too low in lime.

Importance of Fine Grinding

The fineness of grinding is an important feature and one not properly determined by the standard sieve test; although three-quarters of the cement may pass the 200-mesh sieve, the bulk of it may be, and frequently is, too coarse for efficient work, especially if it is high in orthosilicate and low in tricalcium silicate. When a relatively coarse cement of this character is used in concrete work, a petrographic study of thin sections cut from the concrete will prove the presence of a large amount of unhydrated cement clinker. In many cases from 25 to 40 per cent of the cement is unhydrated or partly hydrated, resulting in a weak, permeable concrete mass that readily lends itself to attack by the agents of disintegration.

Fineness of grinding is best determined by means of the air analyzer, which separates into various fractions the cement which passes the 200-mesh sieve.

Since the quality of a cement is in large part dependent on the proportions existing between the components (not oxides) of which it is composed, and since these are determined by the quantity of lime, silica, alumina and ferric oxide present, it is possible to establish a selective ratio based on a minimum tricalcium silicate content. If the percentages of lime, silica, alumina, and ferric oxide, the sum of which in all normal portland cements always exceeds 90 per cent, are converted to molecular ratios, the quotient obtained by dividing the molecular ratio of the lime by the sum of the molecular ratios of the alumina, silica, and ferric oxide, may be used as a selective ratio. The writer suggests 2.4 as the limiting ratio. All cements having a lower ratio than this should be regarded with suspicion.

The limiting ratio provides a simple, easy method of judging the quality of portland cement, when used in connection with the usual standard tests; especially if the fineness of grinding is determined with the air analyzer. A more elaborate and careful study of the quality may be pursued by using petrographic methods in addition.

Application of Recast and Selective Ratio

As an example of the practical application of this method there are included in Table II and Fig. 2 tests and analyses of six standard brands of portland cement. These

TABLE II. TESTS AND ANALYSES OF PORTLAND CEMENTS

Standard Tests	1	2	3	4	5	6
Normal consistency	22.5	22.75	23.0	22.75	23.0	21.0
Time of set, initial	4 hr., 0 m.	5 hr., 30 m.	4 hr., 20 m.	4 hr., 0 m.	2 hr., 45 m.	5 hr., 45 m.
Time of set, final	8 hr., 5 m.	8 hr., 10 m.	6 hr., 30 m.	5 hr., 30 m.	6 hr., 0 m.	7 hr., 15 m.
Specific gravity	3.160	3.155	3.118	3.119	3.130	3.127
Soundness, normal	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.
Soundness, accelerated	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.
Tensile strength, pounds per sq.in.:						
Neat, 7 days	581	669	859	776	635	690
Neat, 28 days	755	716	742	913	778	832
1 : 3 mortar, 7 days	203	240	273	306	175	150
1 : 3 mortar, 28 days	224	273	348	377	254	236
Per cent retained on 200 mesh	20.0	21.4	17.0	19.8	17.6	22.4
Per cent retained on 100 mesh	1.0	1.4	4.0	2.0	2.2	1.6
Compression Tests						
2 in. cubes, 1 : 3 mortar, 6 weeks	1,920	2,448	2,756	2,280	2,380	2,560
Chemical Analysis						
Silica, SiO_2, per cent	23.79	22.61	19.88	21.43	22.14	23.40
Ferric oxide, Fe_2O_3, per cent	2.64	2.51	3.97	2.90	3.17	3.46
Alumina, Al_2O_3, per cent	4.86	6.00	6.73	6.80	5.47	5.24
Calcium oxide, CaO, per cent	61.31	61.37	63.48	62.14	61.80	60.79
Magnesia, MgO, per cent	3.83	4.88	1.25	1.67	2.19	2.46
Water, H_2O (by loss), per cent	2.53	2.10	2.76	2.72	4.00	2.59
Sulphur trioxide, SO_3, percent	1.45	1.41	1.75	1.79	1.24	1.71
Carbon dioxide, CO_2, per cent	0.48	0.33	0.57	0.59	0.59	0.45
Recast						
Calcium carbonate, per cent	1.1	0.8	1.3	1.3	1.3	1.0
Gypsum, per cent	3.1	2.9	3.8	3.8	2.6	3.6
Tricalcium ferrite, per cent	5.2	4.9	7.9	5.9	6.6	6.9
Tricalcium aluminate, per cent	12.7	15.7	17.8	18.1	14.6	14.6
Tricalcium silicate, per cent	19.4	22.1	37.8	23.9	26.2	11.2
Calcium orthosilicate, per cent	53.5	48.2	28.4	43.3	43.7	58.7
Selective ratio	2.38	2.43	2.69	2.50	2.49	2.33

were rated solely from the interpretation of the chemical analyses; the cements themselves were not seen, no micrometric measurements for fineness were made, and the results of the tests were unknown at the time of rating. On the basis of the recasts and the ratios cements Nos. 3 and 4 were judged to be the best; Nos. 2 and 5 the next best; and Nos. 1 and 6 the poorest. The standard tests shown were made subsequently by the Testing Laboratory, Columbia University. The table and diagrams were compiled by the engineers for whom the ratings were made, and are used by their permission.

Portland cement is composed of a mechanical mixture in fine aggregate form, of definite compounds. The proportions in which these exist vary directly as the percentages of lime, silica, alumina and ferric oxide vary. The quality of cement depends upon the proportions existing between these components and upon the relative fineness of the cement. A limiting ratio, based on a minimum content of the best hydraulic component, tricalcium silicate, has been established. Cements falling below this ratio should be looked on with suspicion, especially if relatively coarse, since too high a percentage of the most difficulty hydratable component, calcium orthosilicate, is thereby indicated.

Fluorescein an Aid to Tracing Waters Underground

HOW to use fluorescein in tracing ground water and some of the characteristics of that chemical are noted in the March *Reclamation Record* by Herman Stabler, chief engineer, Land Classification Board, U. S. Geological Survey. The following abstract is given:

Fluorescein, a coal-tar product, stands at the top of the list of chemicals and dyes used for tracing water underground. It has a reddish-orange color but when dissolved in water and diluted appears by reflected light a brilliant green. Its preëminence as an aid to tracing ground water lies in the fact that minute quantities can be detected by the eye without resort to chemical analysis. If material of good quality is used one part of the fluorescein in 40,000,000 parts of water will be visible to the naked eye and one part in 10,000,000,000 can be detected with the aid of a long glass tube. It is useless for waters containing free mineral acids, which render it colorless, and is unsuitable for percolation tests on peaty soils for this reason. With this exception it is available for practically universal application. Some mineral constituents of ordinary waters, particularly carbonates, will reduce the visibility of fluorescein, some of the coloring matter will be absorbed by soils through which it passes slowly and a part tends to settle out in pools or basins, perhaps later to be washed out on agitation by a large inflow of water. These effects are small in most cases but should be considered in determining the "dose" of the indicator to be used. Generaly speaking, the dose should be computed to give about one part in 10,000,000 in the effluent if results visible to the naked eye are desired. The conditions under which the individual experiment is to be undertaken will, of course, furnish some guide to the dosage.

If simple tracing of an underground connection is desired, the proper method is to dissolve the calculated dose of fluorescein in a small quantity of water and place it in a single charge at the point where water disappears underground. Then watch all possible springs or wells for results, collecting samples and examining them in a long tube of colorless glass (long to get the color of a great depth of water, and colorless to avoid confusion with the anticipated green) at reasonably frequent intervals. Seepage from a canal can be traced by placing fluorescein in pits or borings alongside or in the bed of the canal, or, if the canal is closed down, by impregnating a minimum amount of stagnant water in the suspected part of the canal prism. In such cases the rate of underground flow is likely to be only a few feet per day, and there may be a wide diffusion of the waters. A calculated over-dose of fluorescein should therefore generaly be used, and observations should continue long enough to make sure of a result.

Water Chlorination Control by the Absorption Method

Two Years Tests and General Observation Prove That Excess of Residual Chlorine May Be Used as Factor of Safety

By Abel Wolman
Division Engineer, Maryland State Board of Health, Baltimore

THE publication of a paper on "Chlorine Absorption and the Chlorination of Water" (*Jour. Ind. Eng. Chem.*, Mar., 1919, Vol. II, No. 3) by myself and Linn H. Enslow, occasioned at that time considerable inquiry as to the principles and methods of water chlorination control employed in Maryland. In that paper, a general

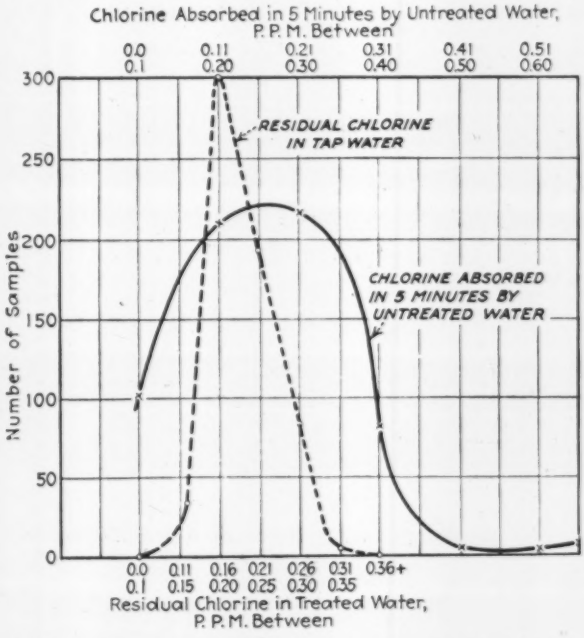


FIG. 1. CHLORINE ABSORBED BY UNTREATED WATER AND RESIDUAL IN TREATED WATER

system of control was outlined in which the essential basis was the effort to hold in a chlorinated water an amount of residual chlorine, after five minutes, equivalent to 0.2 p.p.m. In other words, a hypothesis was set forth that a proper dosage for the effective disinfection of a water was an amount equal to that absorbed by the water tested after contact of five minutes, plus a factor of safety of 0.2 p.p.m. (as a tentative value.)

To demonstrate the validity of this hypothesis, a detailed and adequately controlled series of observations, on a practical scale, was started at Luke, Md. The water supply of Luke is obtained from the Potomac River, a polluted stream. The water is settled without a coagulant and is then filtered. Since that water supply is used for industrial purposes and the present filters are inadequate to furnish the requisite amount of water for such purposes, it has been necessary to filter the water without preliminary coagulation. This combined with the inadequacy of the settling period (about ½ hr.) and high rates of filtration (not less than 125 m.g.d.) produces a poor final effluent made evident by the frequent turbidity. It is essential, therefore, that the chlorination be effective at all times and meet adequately unexpected and sudden changes in the quality of the

filter effluent. For this reason, it was determined to make use of the "chlorine absorption" method in the treatment of this supply. The supervision of the routine testing and the control of the treatment, under the general direction of the Maryland State Department of Health, is in the hands of Mr. Patrick, of the chemical laboratory staff of the West Virginia Pulp and Paper Co., which controls the public water supply at Luke.

Tests—The procedure adopted for the control of the dlsinfection of the water consisted in general of the following steps: (a) The determination of turbidity in all the waters under study. (b) The determination of the amount of free chlorine absorbed in five minutes by the different waters at various stages in purification.

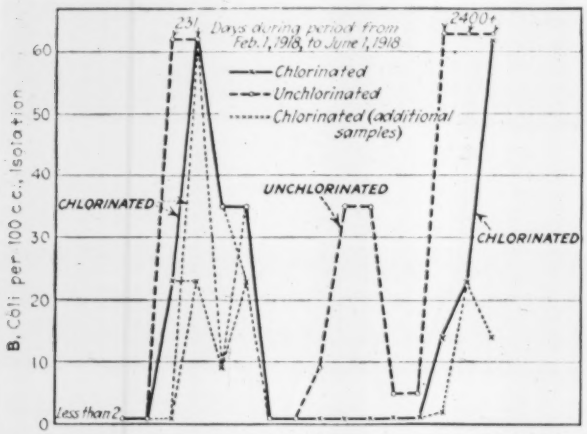


FIG. 2. VARIATION IN B. COLI IN UNCHLORINATED AND CHLORINATED WATER AFTER CHLORINE CONTROL.

(c) The determination of the amount of free chlorine remaining in a tap located at a point approximately five minutes' distance of water travel from the point of application of the liquid chlorine. In the case of the supply under discussion, chlorine was supplied to the suction of the pump. The tests listed under (a), (b) and (c) were carried out in the morning and afternoon of each day of the week. Adjustments of the chlorine machine were made after each test so as to obtain a residual chlorine value of approximately 0.2 p.p.m., at the five-minute tap.

The determinations of chlorine were made with ortho-tolidin. Although the chemist at Luke found this indicator entirely satisfactory, at a number of other plants in Maryland the starch-iodide-thiosulphate method is preferred. In determining the amount of chlorine absorbed during five minutes after the addition of chemical, the following procedure is employed: To 200 c.c. of the water sample (at 20 deg. C) to be treated, add a sufficient volume of available chlorine solution to give a resulting dose of 1 p.p.m. Shake vigorously after stoppering and allow to stand 5 minutes. Immediately shake again for a second and transfer 100 c.c. to a beaker containing 1 c.c. or ortho-tolidin reagent. Place the beaker containing the sample and color reagent in a warm place for 10 to 15 minutes. Dilute 20 to 200 c.c. volume and compare with permanent standard. The residual chlorine in the tap water found as outlined in Standard Methods for Water Analysis, A.P.H.A., 1917.

Results—The Luke chlorination data have been collected for about two years. In this brief discussion, however, it is unnecessary to report all of the values

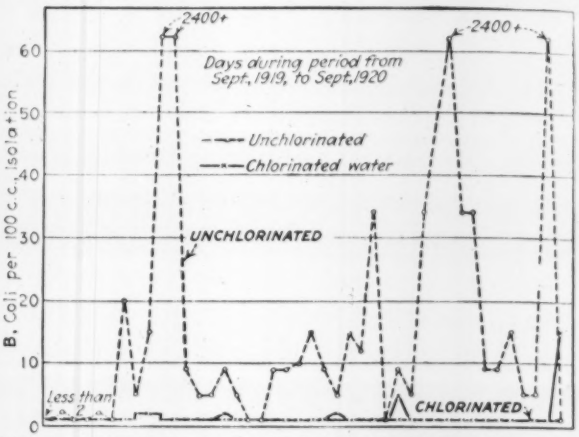


FIG. 3. VARIATION IN B. COLI IN UNCHLORINATED AND CHLORINATED WATER BEFORE CHLORINE CONTROL.

obtained. The material here presented includes only those figures accumulated during the year ending Aug. 31, 1920. They are typical of the previous data and illustrate adequately the conclusions which may be derived. During this period of one year, 622 samples were examined for chlorine absorbed in five minutes and 615 for residual chlorine. The distribution of the values obtained in each case are shown by Fig. 1. Of 615 tap waters examined, 577, or 94 per cent, showed residual chlorine not less than 0.16 and not more than 0.30 p.p.m., while 100 per cent showed not less than 0.11 nor more than 0.35 p.p.m. These results indicate clearly the success with which the chlorine dosage was manipulated to meet varying requirements, since, during the same period, the amounts of chlorine required in five minutes by the water under treatment varied from less than 0.10 to more than 0.60 p.p.m.

The data in Fig. 1 emphasize the variability of the amounts of chlorine which may be consumed by a water during a period of time. Whereas approximately 100 samples of untreated water absorbed less than 0.1 p.p.m. in 5 minutes, 84 consumed between 0.3 and 0.4 p.p.m. and an appreciable number even more than 0.4 p.p.m. Obviously a standardized dosage of 0.3 p.p.m. for such a water as the above would be too low or too high about 75 per cent of the time the water was being treated. Such a dosage would necessarily result in the production either of an unsafe or an unpalatable water during this period.

That these adjustments were satisfactory from the standpoint of bacterial efficiency is shown by the data presented by Fig. 2. Here the B. coli isolation results for filtered unchlorinated and filtered chlorinated waters are presented. During the annual period 82 tap waters were examined. Of these, only two showed more than 2 B. coli per 100 c.c. by the confirmation test (lactose broth, endo, secondary lactose broth). Previous to the institution of the chlorine absorption tests and the regulation of dosages thereby, every fluctuation in bacterial content of untreated water was followed by corresponding rises in that of chlorinated water. (Fig. 3.). The constant chlorine dose, low enough to prevent taste or odor, was a failure from a sanitary standpoint. It is significant to mention that, with the improved method of control, no complaints regarding tastes, odors or corrosion in pipes have appeared in the two years since its initiation.

Conclusions—After two years of operation, the con-

trol of chlorination of a water supply by means of residual chlorine tests has proven a success. This finding is in agreement with that indicated by the treatment, within the past few years, of waters elsewhere than in Maryland.

It appears safe to dose the Luke water at a rate of 0.2 p.p.m. in excess of the amount of chlorine absorbed by it in five minutes. This factor of safety of 0.2 p.p.m. may vary from water to water, but the fundamental principle of chlorination control should remain the same. Although 0.2 p.p.m. may be necessary or undesirable in some waters, yet the method should not be eliminated on this account. The factor of safety may be increased or reduced by varying the period of test

CHLORINATION REPORT SHEET, LUKE WATER SUPPLY
(Figures in parts per million)

January, 1920			5	6	7	8	9	10
Turbidity	Unsettled	a.m.	0	25	5	7	80	48
	Water	p.m.	4	8	7	9	74	42
	Filtered	a.m.	0	0	0	0	11	20
	Water	p.m.	0	0	0	0	14	13
Available chlorine absorbed in 5 min.	Unsettled	a.m.	0 36	0 35	0 38	0 33	0 65	0 60
	Water	p.m.	0 36	0 38	0 37	0 34	0 65	0 30
	Filtered	a.m.	0 33	0 34	0 35	0 31	0 19	0 44
	Water	p.m.	0 34	0 34	0 35	0 31	0 19	0 26
Residual chlorine	Tap	a.m.	0 19	0 20	0 18	0 23	0 20	0 10
	Water	p.m.	0.22	0.23	0 18	0 20	0 16	0.22

for chlorine absorption of unchlorinated water. In general, however, the simplest form of chlorination control, and the one which should give complete satisfaction, would consist in maintaining a quantitative residual of chlorine at a definite station near the point of application of the chemical. What this quantitative residual should be is dependent upon the supply. In the case of the supply here reported upon, 0.2 p.p.m. appears satisfactory. With another water, more or less than 0.2 might be preferable for the best sanitary and aesthetic results. But in each case, it certainly appears wise to recognize the fundamental principle of variability of chlorine consumption of water from day to day and hour to hour before attempting to meet this variability by invariable dosage. In the primary equation of chlorination, the factors on one side are "chlorine demand" and "chlorine supply" and, on the other, bacterial content and taste and odor. If "chlorine demand" varies, and it always does, while "chlorine supply" remains constant, as it usually does in the average treatment plant, why should it be expected that increased bacterial content and tastes and odors would not come and go?

The maintenance of the equilibrium of the factors in the equation here described gives rise to the interesting query to the writer by Dr. William Mansfield Clark of the U. S. Public Health Service: "Why not a chlorine apparatus which will feed automatically a dosage varying with the absorption of the water being treated?"

Acknowledgment—The careful analytical determinations and supervision here reported upon were made possible by the interest displayed in the experiments by Mr. Patrick. The foregoing discussion has been considerably clarified through valuable criticism and suggestions by the Robert B. Morse chief engineer, Department of Health, whose broad interest in such problems has made their study possible.

Problem of Better Harbor Freight Handling Methods

Ship's Gear and Cranes Working Simultaneously—Tractor-Trailers for Pier Sheds and Warehouses—Car-Lighter Transfer

WHILE THE LACK of freight-handling machinery at the port of New York is by no means as pronounced as is generally believed, there is ample opportunity for improvement in installations and methods, according to the New York, New Jersey Port and Harbor Development Commission as set forth in the chapter on freight-handling machinery in its recent report. It is recognized that a large percentage of cargo transfer at New York is and will remain to and from lighters on the offshore side of the ship, where wharf machinery is of no avail. Nevertheless wharf cranes for use simultaneously with ship's gear together with tractors and trailers to move the goods within the pier shed, the commission believes would materially reduce the turnaround of the average ship, provided other changes in pier operation were made that would relieve the pier shed of warehouse duty. The commission compares at some length tractor-trailer operation with overhead monorail operation and finds in favor of the former for both transit sheds and warehouses.

More general improvement in methods of loading and unloading coastal vessels with side ports is suggested by the successful application at a few points of gangplank boosters and the practice of carrying the freight on the vessel in loaded trailers handled by tractors on the piers. For loading and unloading canal and other barges better waterfront equipment, such as cranes, grab buckets and hoists, is needed, particularly for canal barges and for some quarters in handling special commodities in large quantities. In the case of warehouses, resulting economies will warrant liberal investments in large elevators, conveyors, chutes, tiering machines and outside hoists, in addition to tractors.

Ship's Gear Versus Cranes

In view of the respective advantages and disadvantages of ship's gear and wharf cranes, the commission believes both should be available to promote the most rapid discharging and loading of the average cargo carrier.

With respect to ship's gear, it is standardized equipment. Almost every ship has it, to enable it to operate in ports not equipped with cargo-handling machinery. Its use is understood the world over, and no very high intelligence is required to operate it. It can operate on either the pier side or the off side of the ship, and working in conjunction with cargo masts it can function with little loss of time while the ship is breasted off for coaling.

On the other hand, the average ship has not enough gear to work all hatches to capacity. In the ordinary burtoning operation without the aid of cargo masts two booms are required for one hook, and studies made by the commision of typical ships showed that in many instances several cranes could have worked to advantage in addition to all of the ship's tackle. The cranes can work from the pier while the ship's booms work the same hatches from the offshore side, or the cranes and booms can work in team, the crane handling the load between pier and ship's deck, the latter between the

deck and the hold. The latter combined operation, while only one of the possibilities where both cranes and ship's gear are available, has been used to some extent at certain European ports.

Wharf cranes have certain other advantages over ship's gear. The crane is ordinarily designed for a larger load than ship's gear can handle, and usually two cranes can be worked together to handle loads of double the capacity of the single draft. The traveling crane is not restricted to a certain spot, as is usually the case with ship's gear. Wharf cranes can be used effectively transferring goods between pier and lighter when no ship is in berth.

Saving in Ship's Turnaround

"Simultaneous working of ship's gear and cranes," states the commission, "would effect a saving in the ship's time, but without improved layout and provision of ample transit floor space the benefit of cranes would not fully materialize. With such provisions, together with adequate regulation to insure deliveries of goods to and removal from the pier at the proper times, it seems conservative to say that the present average time of discharging and reloading can be cut in two.

"Twenty days is about the average time required [for average freighters] for the two operations of discharging and loading. Less than one-fifth of the total time the ship is at the pier is actually used in working the hatches. . . . Evidently there are reasons for the waste of ship's time in the harbor other than the lack of machinery. The rehandling of freight on account of lack of transit floor space for incoming cargo, insufficiency of space to assemble outgoing cargo, and the untimely arrival of outgoing cargo stand prominent among these reasons, and cause relatively greater delay than could be made up by any crane installation."

The commission gives figures of $1,000 and $4,000, between which lies the charter value per day of the average ship of 4,000 net vessel tons. An average saving in turnaround of ten days might therefore be the interest on either $200,000 or $800,000, but in either case, considering the number of dockings in a year at one pier, the commission thinks high first cost need not bar the installation of machinery.

It is pointed out that cranes can be installed successfully only where the piers are strong enough to carry them, where the sheds are set back far enough to permit unhampered operation and where the piers are wide enough for prompt movement of the goods to and from the ship. These conditions do not obtain at most of New York's existing piers. The commission recommends the building of new piers of such dimensions and design as will accommodate cranes, the nature of the traffic to determine whether the cranes should be at once installed.

Transit-shed layout and operation may largely nullify the benefits of cranes. Narrowness of piers, abuse of storage privileges in transit sheds and insufficient use of handling machinery—tractor-trailers or monorail systems—within the shed may be contributing causes.

The commission holds that a basic necessity if machinery is to be effective is the provision of adequate and accessible warehouse space and the restoration of the pier or transit shed to what its name implies—a covered space for goods moving to and from the ship.

Assuming, then, that the transit shed is to be put to its proper use, the commission points to two systems as best meeting the controlling requirements—the tractor-trailer system and the overhead monorail crane or adjustable loop system. It is believed that electric tractors and trailers, supplemented by hand trucks for short distances and limited space, and by electric load carrying trucks in exceptional cases, afford the best means available, based upon the monorail and the tractor-trailer systems as at present available for pier use.

In speed and cost of operation the commission finds little choice in the two systems. In flexibility and in adaptability to commercial practice, however, the advantage is thought to be decidedly with the tractor-trailer operation.

Tractors and trailers can go anywhere. Monorail systems are restricted to one-way operation, and are further restricted by columns and other interior obstructions that make it difficult to reach all parts of the building. Adjustable loops only partly overcome the difficulty. If there is only one loop, only one or two hatches can be worked successfully; if there are more than one, each restricts the scope of the others.

The ordinary cargo consists of every manner of commodity, in every manner of size, shape and strength of package. It can best be classified on a wide pier, where it can be spread out. Tractor-trailers work best on such a wide area. Because of the high cost of traveling monorail bridges, however, sheds where they are used must be kept narrow and the goods must be tiered high to get the capacity. This is often unsafe, and the relative inaccessibility of the goods in the high piles adds to the difficulty of sorting them.

Serving Coastal and River Vessels

Even though coastal and river vessels individually represent a smaller investment than trans-oceanic steamers, their operation on fixed schedules requires prompt unloading and loading. In maintaining schedules with side-port loading of vessels, with single or multiple decks, there is little opportunity for other machinery than power trucks and trailers supplemented by a large amount of hand labor. Improvements are gangplank boosters, use of tractor-trailers and the carrying of loaded trailers on the boat between ports. The adjustable ramp or gangway equipped with an inclined conveyor is simply an endless motor-driven chain carrying at frequent intervals lugs that engage the axles of the hand trucks and "boost" them up the incline. The tractor-trailer system has been developed to a considerable extent on piers serving broad, low-sided, shallow-draft vessels for sheltered waters, with extension of the system by receiving all outbound freight to the steamer by trucks, in connection with tractor-trailer distribution on the pier.

An advance use of the tractor-trailer system for pier work in loading vessels of the side-port class, but not applicable to all cases, is that the trailers are left on board the vessel and taken off at destination, handled by tractors at each port. Since most freight cannot be tiered successfully on top of a succession of loaded trailers, there is a considerable amount of unused volume space, suggesting the possibility of inserting decks between those existing.

Harbor and canal craft barges in general include such a variety of boats in various services that it is difficult to outline specific needs for betterment of practice. In the case of lighters it has been seen that wharf cranes will facilitate their operation. While the pres-

ent volume of lighterage transfer at the port of New York has been criticised, it should be realized that the capacity of the port to use them is an element of strength and not of weakness, since wide ranges of type and capacity seem to conform to the demands of service and the high capacity derrick boat has proven an excellent medium for transferring heavy parts to and from piers, ships or cars.

A special field for the canal is the transportation of low-grade bulk freight naturally carried in hold barges or boxes. Loading and unloading can best be accomplished by shore equipment and there is a crying need for such equipment and for cranes to handle package freight, as well as for the wharves themselves to handle the canal traffic. Hold barges used for carrying coal, grain, sand, gravel and other bulk freight operate not only from the canal but also between various points within the harbor. The whole question of better machinery for serving them is tied to the larger question of a more rational selection of terminal sites for handling the various commodities.

Railroad Transfer

There is some but not much direct transfer between car and ship at the piers of the port of New York. Miscellaneous package freight is handled mainly at the covered lighterage piers, unloading cars to hand trucks which run aboard lighters. The problem peculiar to the port of New York is the transfer of heavy pieces for export and import to and from cars, performed mainly by cranes at open piers, but very little to and from ships.

The two general classes of equipment in use for this service are the locomotive crane and the overhead crane. The lower cost of the locomotive crane is one of its strong points, together with its flexibility by use on any existing track without pier modifications. Overhead cranes now in use—both straight line and revolving—range between 10- and 30-ton capacity, some with 5-ton auxiliary hoists. It is believed that the revolving type is preferable at uncovered lighterage piers because it can reach additional trackage and so reduce shifting. Either type is more efficient than the locomotive crane for frequent and intensive service on an open pier.

Since the heavier types of crane on open railroad piers at the port of New York are used almost exclusively for transfer of freight between cars and lighters, mostly at shallow water, they are in no way comparable to those at some foreign ports or to those here recommended for general cargo at steamship piers, and finally because such cranes are of altogether too high capacity for general cargo transfer. The advantage is not wholly with the pier crane in heavy transfer between ship and car direct. While no material difference in operating cost can be observed between the pier crane and the floating crane, the advantages in flexibility of operation rest with the latter.

Observations made of comparative performance of pier cranes and floating cranes for the handling of heavy drafts from open railroad piers indicate little difference in labor cost, the floating crane having a slight advantage. In the matter of dispatch, however, the floating crane made decidedly the best showing. In one comparison a floating crane taking a small number of drafts of about six tons each averaged 45 tons per hour, while a 20-ton pier crane taking an average draft of 5½ tons averaged only 18 tons per hour, and a 10-ton pier crane taking an average draft of 2,200 lb. averaged only 13 tons per hour. Cost figures are not illuminating since floating-crane operation involves lighterage operation also. The conclusion is drawn that the field of the open-pier railroad crane is between that of the recommended wharf crane for general cargo and the high-capacity floating crane.

Warehouse Machinery

In the well-ordered multiple-story warehouse there are some five requisites to the business of storing and handling goods: (1) Means of handling goods in and out and to and from other transportation units; (2) means of conveying goods about the floors; (3) means of getting them from one floor to another; (4) means of tiering and removal to conserve space, and (5) facilities for weighing.

While virtually all warehouses are accessible to street trucks, many lack railroad service and only a comparatively few are on the water front accessible to lighters.

In movement about floors some of the disadvantages of the adjustable loop monorail system for wharf-shed purposes are not so evident, but the need for utilizing full cubical capacity is more pronounced than in the wharf shed. Hence the monorail system wastes much more space overhead than the tractor-trailer system wastes in wider aisles, except possibly in the case of commodities that can be tiered high. Generally the warehouse should be contiguous to the wharf shed or nearly enough so that tractors and trailers can operate between. Where this access is not available, conveyors or moving platforms may be especially desirable in connection with multiple-story wharf sheds.

Tiering machines and their complement, de-tiering machines, are needed for full use of warehouse capacity with high ceilings. A good machine for warehouses of this type is the portable inclined conveyor, taking the package at the floor or track level and delivering it to any desired height.

Transcontinental Radio Signals in Moving Automobiles

Signals sent out by Atlantic Coast radio stations were received recently by apparatus carried in an automobile moving along the streets of San Francisco. The antennae consisted of a stranded copper wire aërial hung about 10 ft. above the ground by means of bamboo poles at the front and rear of the automobile. Nothing but the frame of the machine was used for a "ground." The signals were clearly audible without the use of amplification, only one bulb being used. Except for a six-volt storage battery the receiving set was entirely contained within a small cabinet of about the same size as an ordinary suit case. The set was not specially made up for this purpose, but is a standard product turned out by a San Francisco radio manufacturer.

The first tests were made on top of Twin Peaks, an eminence in a part of the City where power lines and street cars would not interfere with the signals. The test was so successful there that the automobile was driven down into the City and the signals continued to be clearly audible even when the automobile was driven close to electric cars in operation. Some of the distant stations heard were Marion, Mass.; Annapolis, Md.; New Brunswick, N. J., and Pearl Harbor, Hawaii. E. A. Portal and Colin B. Kennedy conducted the demonstration.

Concrete Road Building Delays in Illinois Analyzed

By A. W. Consoer,
General Manager, Consoer Engineering Co., Chicago

ROAD and paving contractors seldom realize how few days they are actually engaged in the essential work of their contracts and how much avoidable delay and increased cost there is in their construction operations. The accompanying table shows the amount of time lost through delays on nine typical concrete road contracts in Cook Co., Ill. Much of this delay was, of course, due to causes over which the contractor had no control and some is entirely justifiable, but the differences in the records of the various contractors in the same county show that much of the delay in these nine instances can be correctly classed as avoidable. The cost of a high priced organization is a serious matter when no dirt is being moved, or when no concrete is being laid.

The principal delays in most of the nine contracts are classified under the heading "Administration." Under this general heading are included all delays in starting or suspending any part of the work for reasons not otherwise covered.

TABLE—TABULATION AND ANALYSIS OF CONSTRUCTION DELAYS ON NINE ILLINOIS HIGHWAY CONTRACTS

Description of Job (All Pavement) 18 ft. wide	Operations	Delays (Days)																		Work Performed					
		Administration	Rain and Wet Ground	Cold Weather	Short Gang	Lack of Material	Hauling Delay	Waiting for Grade	Cutting Out Grade	Machinery and Moving	Waiting for Mixer	Waiting for X-Culvert	Preparation	Building Culverts	R.R. Strike	Teamster's Strike	Truck Driver's Strike	Shut Down	Building Plant	Total Delays	Actual Days Worked	Possible Days		Av. Size of Gang	Actual Av. per Man per Day	Total Av. per Man per Day	High Run	Low Run	Av. Run
No. 1	Excavation	92	12	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	106	49	155	10,000	9	23	7			
2-bag mixer	Hauling material	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	155		..	..	..			
10,240-ft. long	Paving	54	14	..	..	17	..	31	..	3½	..	..	2	..	..	..	..	..	..	121½	34	155	5,388	15	11	2	275	37	168
Contract Let	Shoulders and																											
May 5, 1919	ditches	130	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	130	25	155	4,000	8	20	3	..	..	
No. 2	Excavation	38	16	4	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	60	114	174	28,106	15	64	11	..	..	
2 & 3-bag mixers																												
28,106-ft. long	Hauling material	27	16	4	1	12	..	7	..	..	..	..	..	..	..	..	..	..	..	67	107	174	.....	12	..	..	..	..	..
Cont. Let																												
May 21, 1919	Paving	27	16	4	2	17	2	7	..	2	..	..	..	..	..	..	..	..	..	77	97	174	28,106	27	11	6	412	27	282
Completed	Shoulders and																											
Nov. 22, 1919	ditches	113	16	4	1	..	..	..	..	..	8	..	..	..	..	..	..	..	..	142	32	174	18,000	15	38	7	..	..	
No. 3	Excavation	27	3	..	..	..	..	..	..	..	..	..	..	19	..	..	..	..	..	49	52	101	16,123	12	26	13	..	..	
2-bag Mixer																												
16,123-ft. long	Hauling material	22	4	..	..	10	4	..	..	..	..	..	..	19	..	..	..	..	..	59	66	125	.....	8	..	..	..	..	..
1 Cont. Let	Paving	22	5	..	..	10	..	10	..	6	..	..	..	19	..	..	..	..	..	72	53	125	16,123	37	8	4	420	25	314
Apr. 1, 1919	Shoulders and																											
	ditches	93	..	..	..	..	..	..	..	..	..	..	..	19	..	..	..	..	..	112	..	112	.....	..	..	..	..	..	..
No. 4	Excavation	40	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	43	94	137	13,755	4	37	25	..	..	
1-bag Mixer																												
13,755-ft. long	Hauling material	36	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	38	99	137	.....	10	..	..	..	..	..
Cont. Let																												
June 1, 1919	Paving	41	3	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	46	92	138	13,755	14	11	7	204	47	150
Completed	Shoulders and																											
Nov. 20, 1919	ditches	142	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	143	41	184	13,755	10	34	7	..	..	
No. 5	Excavation	67	58	78	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	204	57	261	16,323	12	24	5	..	..	
3-bag Mixer																												
16,323-ft. long	Hauling material	98	56	50	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	204	57	261	.....	..	..	..	..	..	..
Cont. Let																												
Sept. 16, 1918	Paving	70	58	78	1	..	..	6	..	..	..	..	..	..	..	..	..	..	..	213	57	270	16,323	34	8	2	448	106	286
Completed	Shoulders and																											
July 15, 1919	ditches	152	58	59	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	269	..	275	.....	..	..	..	..	..	..
No. 6	Excavation	22	32	73	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	128	66	194	11,372	8	22	8	..	..	
2 1-bag mixers																												
11,372-ft. long	Hauling material	19	32	73	0.3	..	..	17	..	..	..	..	..	..	..	..	..	..	..	142	52	194	.....	..	..	..	..	..	..
Cont. Let																												
Sept. 23, 1918	Paving	29	33	73	2.7	..	..	9	..	..	..	..	..	..	..	..	..	..	..	147	40	187	11,372	25	11	3	458	24	282
Completed	Shoulders and																											
May 30, 1919	ditches	54	31	73	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	158	..	158	.....	..	..	..	..	..	..
No. 7	Excavation	12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	12	17	29	2,687	9	18	10	..	..	
2-bag Mixer																												
2,687-ft. long	Hauling material	12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	12	31	43	.....	..	..	..	..	..	..
Cont. Let																												
May 5, 1919	Paving	27	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	29	14	43	2,687	15	13	4	252	149	192
Complete	Shoulders and																											
June 25, 1919	ditches	53	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	53	5	58	.....	..	..	..	..	..	..
No. 8	Excavation	29	38	4	1	1	..	..	..	1	..	..	..	..	..	6	..	..	..	81	97	178	30,000	14	22	12	..	..	
4-bag Mixer																												
31,784-ft. long	Hauling material	19	38	4	2	..	2	..	..	1	..	..	..	..	5	1	1	..	..	73	105	178	.....	..	..	..	..	..	..
Cont. Let	Paving	38	42	4	2	1½	..	..	..	5	..	..	..	..	6	2	2	1	..	105	73	178	23,054	30	11	4	470	47	317
May 5, 1919	Shoulders and																											
	ditches	132	31	4	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	168	10	178	1,200	8	15	1	..	..	
No. 9	Excavation	48	9	2	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	60	109	169	44,056	12	34	22	..	..	
4-bag Mixer	Hauling material	30	8½	..	..	10½	..	..	..	3	..	..	..	..	..	..	..	..	43	95	55	150	.....	..	..	..	..	..	..
49,263-ft. long	Paving	30	5½	..	..	10½	..	..	..	3	..	..	..	..	..	..	..	..	43	92	58	150	21,482	23	16	6	751	81	370
Cont. Let	Shoulders and																											
May 5, 1919	ditches	134	9	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.....	..	..	..	..	..	..

NOTE—Work performed is expressed in lineal feet of road. Delays are expressed in days.

Delays of administration in excavation work include, for example, the time required for the formalities of signing the contract, procuring bond and obtaining approval of the sureties, shipment of equipment and organization of the construction forces after the award of contract. Delays of administration under paving include the days when no paving was done after suffi-

cient grading had been done and sufficient material had been spotted to warrant the beginning of concreting.

Most of these contracts were awarded in May or June, 1919, and there should have been no unnecessary delay in starting the work, as cold weather causes a cessation of concrete paving work in Cook Co. usually about Nov. 1. The fact that so much delay was required for organization work is a direct appeal for awarding contracts early in the season, in order that organization can be done in the winter and early spring.

Surprisingly little delay was caused by lack of materials. On 1920 contracts the lack of materials has frequently caused considerable delay, and has converted many contractors to the practice of storing reserves of material before commencing work, in spite of the additional cost involved. It is common practice on state and county road contracts in Illinois and neighboring states for the engineer to give estimates on material stored near the work, but in municipal paving work this method for encouraging the storing of cement and aggregates has not been so generally adopted.

A striking example of avoidable delay is given under Contract 1, where 31 days' were lost in the actual paving by failure to have the subgrade prepared in time to permit continuous operation of the mixer.

On Contract 9, 43 days were used in building and equipping an unloading plant and industrial railroad, and only 55 days were actually utilized for laying pavement. If this contract had been awarded on March 1 instead of May 5, the contractor might have completed the 49,263 ft. of road in 1919 at a good profit instead of having to face the increased cost of labor when he resumed construction in the spring of 1920 on the uncompleted portion of his contract.

Many highway engineers and contractors favor awarding contracts in sections about 5 mi. long. A study of the table indicates that such a contract can be completed by the usual contractor's outfit in one season in Cook County, if the work is let early enough to allow construction operations to begin as soon as weather conditions permit. In Contract 2, the contractor was able to complete all of the 28,106 ft. of pavement, but had not completed the earth shoulders and ditches when cold weather forced him to suspend operations.

On all these contracts there was a tendency not to have more than one or two major operations under way at one time. In none of these cases was a real effort made to complete the earth shoulders and ditches as rapidly as the curing of the finished pavement was completed. The table shows also how long the average contractor in this county delays starting his concreting operations after sufficient grading has been done and sufficient material hauled to warrant a start. A certain length of time is always required to assemble and organize working force and equipment.

A number of contractors when shown these figures were startled by the conditions revealed. While they all realized that much time is lost by delays, none of them had known what a small part of the total working time was effectually utilized on the average contract.

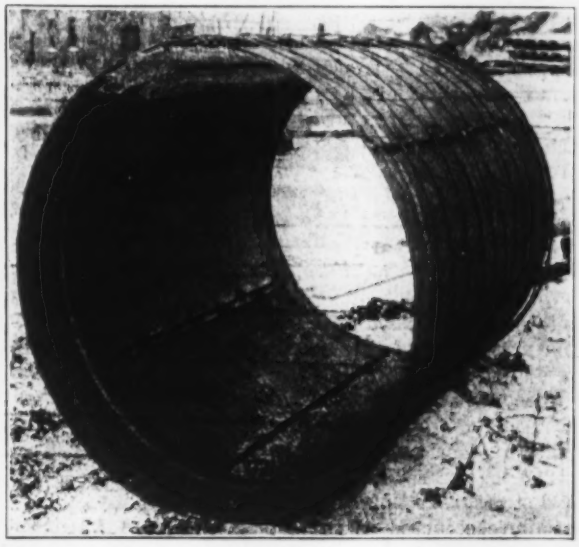
Paint Value Diagram by E. O. Johnson

The diagram for carrying out cost and value calculations of paint, in *Engineering News-Record* of April 7, p. 601, was originated by E. O. Johnson, East Orange, N. J., whose name should have appeared as author of the article referred to.

Test Concrete Pressure Pipe With Encased Steel Diaphragm

Inside of Reinforced-Concrete Shell Is a $\frac{3}{16}$-in. Steel Pipe Which Is Welded at Joints Between Cast Sections

TESTS have recently been made at Cleveland, O., on a 36-in. precast reinforced-concrete pipe of a new type, in which an encased $\frac{3}{16}$-in. steel cylinder acts as a water barrier for high pressures. The pipes are cast in sections 4 ft. long with the encased steel cylinders projecting and the joint is made by electrically spot welding the steel and pouring concrete in the joint. On both



BELL END OF STEEL SHELL WITH OUTSIDE REINFORCEMENT IN PLACE

inside and outside faces of the encased steel are welded perforated strips of metal which serve as spacers for wire-mesh reinforcement, No. 153 on the outside and No. 032 on the inside. The concrete shell is 4 in. thick.

The bell and spigot ends of each section were built up of developed sheets of $\frac{3}{16}$-in. steel plate. The bell end was constructed of a strip of the material so patterned that when developed it formed a conical shaped cylindrical ring $7\frac{1}{2}$ in. wide, which was attached to the end of the main cylinder by means of a continuous outside welded joint. A somewhat similar ring was developed for the spigot end of the pipe. Into the small end of this ring, however, was rolled a crimp expansion joint, which in section had the form of a half circle of $\frac{1}{2}$ in. diameter. This ring was welded to the opposite end of the main cylinder.

The pipe sections were cast on end. Steel forms, which were set up on an accurately machined cast-iron ring, were used. This ring also served as a template on which the bell section of the steel diaphragm was centered The spigot, or upper end, of the diaphragm was held accurately centered by means of removable steel lugs.

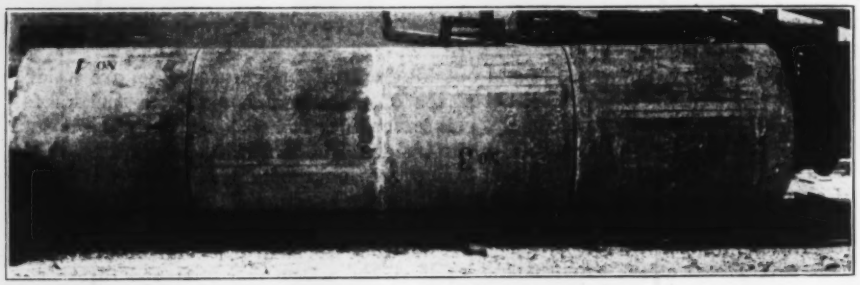
Concrete was mixed one part of portland cement, two parts Pelee Island sand and four parts roofing gravel by volume. It was poured rather wet and was spaded with a flexible ramming rod. After the pipes were cast they were steamed, when the temperature was around freezing, and stripped after from 2 to 9 days.

Four pieces of the pipe were erected on timber skids for an internal pressure test. The steel diaphragm of the several sections were connected by means of a continuous electric weld made from the inside, and steel bulkheads were welded to the diaphragm protruding from the ends of the test sections. The pipe was designed for an internal pressure of 115 lb. per square inch, using 12,000 lb. stress in the steel. Water pressure was applied by means of a boiler test pump and the pressure was raised to 230 lb. per square inch, at which point horizontal cracks were noticed in the concrete of the two end sections. At 240 lb. per square inch pressure horizontal cracks were noted in the concrete of the remaining two sections.

SPIGOT END OF ONE PRE-CAST SECTION

The cracks were apparently caused by the fact that the steel diaphragm was being stressed to a point beyond a safe working load. The stress in the ¼-in. steel shell, at 230 lb. per square inch pressure would result in a total stress of 24,572 lb. per square inch.

Failure occurred in one of the end pipes when the internal water pressure was increased to 255 lb. per square inch, or 27,243 lb. per square inch stress on the steel diaphragm. The rupture was caused by the failure of a large portion of the longitudinal lap weld which extended through the length of the main cylinder of the 4-ft. section. In breaking, the concrete on both the inside and outside was shattered. It is of interest to note that the concrete was but twenty-three days old when the test was made.



FOUR SECTIONS OF CONCRETE PIPE BEING TESTED

In regard to the test the engineer's report reads:

"The concrete pipe used in this test was designed and constructed to withstand an internal working pressure of 115 lb. per square inch. Observations made at the time of the test showed that a longitudinal crack developed in the two end pipes at 230 lb. per square inch pressure. Subsequent investigation proved that the cracks occurred over the lap welded horizontal joint The lap used in standard welding practice of four times the thickness of the sheet, or ¼ in. in this case, was used Undoubtedly, the type of lap weld joint used in the longitudinal seam intensified the strain on the weld However, a satisfactory butt weld or a double welded lap joint will undoubtedly develop the full strength of the shell. The results of the tests indicate that in the design of the pipe the wire mesh reinforcing might well be assigned a portion of the stress. In fact, it might be given the greater part of the stress, in which case it would seem advisable to increase the thickness of the concrete on the outside in order that the wire mesh may be spaced a great distance from the steel cylinder. In such a design the steel cylinder could be made as light as practicable to handle, thus serving almost entirely as a continuous imperforated diaphragm. We understand that the thick sheet was used in the test only in order that the welded joints might be more effectually tested."

The test was conducted by the United Concrete Pipe Co. of New York City, which manufactures the pipe, and was reported on by Morris Knowles, Inc., Engineers, Cleveland, Ohio.

Construction Costs of 1920 and 1921

IN THE submission of estimates for the construction of a three-story apartment house in Illinois, the bids submitted on Jan. 10, 1921, showed a decrease of approximately 15 per cent in cost over the bids submitted on the same type of building on May 20, 1920. The apartment building contained a basement, and eighteen apartments, each apartment consisting of six rooms and three baths. The size of the living rooms were 18 x 25 ft., dining rooms 16 x 20 ft. and bedrooms 14 x 17 ft. There was nothing unusual in the construction and equipment of the building, and medium high-grade standard material was specified. The low bids received on Jan. 10 were not from the same contractors who submitted low bids in 1920, although all estimates were presented by reliable firms. The figures herewith presented were included in an article by S. E. Davidson, president of the Illinois Society of Architects in a recent issue of the *American Architect*. In the same article Mr. Davidson presents figures upon a small manufacturing plant located in Chicago, showing the comparative costs of its construction on July 19, 1920, and Jan. 19, 1921. This comparison indicates that 1921 prices are 9 per cent under those of July, 1920.

In the figures upon the construction of the apartment house, the following itemized cost is given:

Classification	Cost as of May 20, 1920	Cost as of Jan. 10, 1921	Per Cent of Increase or Decrease
Masonry	$44,300	$40,220	— 9 4
Carpentry	74,000	55,700	—24 7
Concrete	5,200	4,650	—10 5
Stone	5,578	6,200	+11 1
Plumbing	28,100	25,870	— 7 9
Heating	11,250	10,600	— 0 6
Electric	4,525	4,300	— 0 5
Plastering	22,200	17,400	—21 6
Steel	4,629	4,209	— 9 1
Sheet metal	2,890	2,960	+ 0 2
Painting	14,920	12,300	—17 6
Glass	2,113	2,200	+ 4 1
Tile	5,843	5,700	— 2 4
Total	$225,548	$192,309	-14 7

The small manufacturing plant was composed of a number of one, two and three-story standard mill, sprinklered buildings, including a separate power house. The plant was designed to secure the most economic construction costs. The figures here quoted are from the same contractor in each case:

Classification	Cost as of July 19, 1920	Cost as of Jan. 19, 1921	Percentage of Increase or Decrease
Masonry } Concrete } Carpentry	$281,480	$249,740	− 11 2
Radial brick chimney	5,930	5,870	− 1 0
Water tube boilers	14,590	14,224	− 2 5
Furnaces	3,400	3,400	0
Structural steel } Miscellaneous iron	32,330	25,740	−20 4
Steel sash	21,814	24,569	+12 6
Fire escapes	2,872	2,738	− 4 8
Fire doors, etc	6,525	6,310	− 3 3
Hollow metal doors	1,857	1,857	0
Sheet metal work	5,076	4,560	− 10 2
Glazing	19,920	21,980	+10 3
Plastering	7,715	7,715	0
Cut stone	1,360	1,250	− 8 1
Elevators	5,200	4,500	−13 5
Roofing	16,570	16,400	− 1
Tile flooring	102	92	− 9 8
Painting	13,763	12,662	− 8 0
Heating	70,000	61,000	−12 8
Pipe covering	5,062	4,556	− 10 0
Electric wiring	24,336	21,006	−13 6
Sprinkler equipment	34,956	32,115	− 8 1
Gravity tanks	7,075	6,297	− 10 9
Plumbing and drainage	20,290	19,276	− 4 9
Fire pump	3,125	3,425	+ 9 6
Total	605,348	551,282	− 8 9

Formula for Determining Settling Periods in Basins or Tanks

BY THORNDIKE SAVILLE
Associate Professor Hydraulic and Sanitary Engineering, University of North Carolina, Chapel Hill.

THE design of horizontal-flow settling basins for the treatment of water or sewage is usually based upon the time of settlement, which in turn is governed by velocity of flow. The cross-sectional area of the basin or chamber is a function of these two elements.

The writer, as a post graduate student in two of the better known technical schools in the East, well remembers arduously computing the settling period for various cross-sectional areas and lengths of horizontal-flow settling basins. It is on this account only, and because of absence of any similar computations in textbooks on water or sewage treatment that he ventures to outline the following brief formula for readily calculating settling periods. A similar formula has no doubt been developed by many practicing engineers, but the one presented below may be of some use to younger engineers on account of the absence of similar formulas in texts. The method is of especial use where it is desired to calculate directly the settling periods for various dimensions of tank without finding the velocity of flow. Let

C = Contribution of sewage in gallons per capita per day
P = Population tributary
$Q = CP$ = total flow in gallons per day
q = rate of flow in cubic feet per second
V = Velocity of flow through tank in feet per second
A = Cross-sectional area of tank
L = Length of tank
N = Number of hours during which flow is assumed to occur
S = Settling period in hours

Then $V = q/a$

$q = CP/(N \times 3{,}600 \times 7.5) = Q/(N \times 3{,}600 \times 7.5)$

$V = A/(AN \times 3{,}600 \times 7.5) = Q/(27{,}000\ AN)$

$S = L/(V \times 3{,}600) = L/(Q \times 3{,}600)/(AN \times 3{,}600 \times 7.5) = (7.5\ LAN)/Q$

For example: A sewage district of 1,000 population contributes 80 gal. per capita per day to a settling tank 15 ft. x 10 ft. in cross section and 25 ft. long. If the entire flow is assumed to occur in 18 hours, what is the rate of flow and settling period in the tank?

$V = Q/(27{,}000\ AN) = (1{,}000 \times 80)/(27{,}000 \times 150 \times 18) = 80{,}000/(72{,}900{,}000) = 0.0011$ ft. per second.

Thence:

$S = L/(V \times 3{,}600) = 25/(0.0011 \times 3{,}600) = 6.3$ hours or directly,

$S = (7.5\ LAN)\ Q = (7.5 \times 25 \times 150 \times 18)/(1{,}000 \times 80) = (506{,}250)/(80{,}000) = 6.3$ hours.

Ditch Design for Prevention of Silt Deposit

Mean Velocity of Stream Must Increase with Depth To Maintain Silt—Carrying Capacity—Formula for Velocity

IN THE FLOW and sedimentation of drainage ditches there is a close relation between velocity, depth and width, particularly at junctions and sharp breaks in grade. If the velocity can be controlled at these critical points it is possible to eliminate much sedimentation and thereby to reduce maintenance costs. These statements summarize a paper on "Ditch Design and Prevention of Silt Deposit," presented at the annual meeting of the Iowa Engineering Society by Q. O. Ayres, Iowa State College. An abstract follows:

The silt-supporting power or silt-carrying capacity of a stream is derived from the upward component of the velocity of eddies. As eddying is aggravated by high velocities and shallow depths, the silt carrying capacity is likely to vary directly with some function of the velocity and inversely with the depth. Width is a factor because the wider the stream the greater the number of eddies.

For uniform flow in a stream there will be a constant value for the sum of its potential energy and kinetic energy, represented by depth of flow and velocity head respectively. If the depth is increased the velocity head is decreased automatically; and if the depth is decreased the velocity head is increased, provided that the slope remains constant.

As silt carrying capacity is largely a function of velocity head, the problem at ditch and grade junctions is to keep the kinetic energy above a certain minimum value by varying the depth of flow, which implies increasing the width of ditch to care for a given discharge. The velocity which is high enough to prevent silting and low enough to avoid erosion, and which varies with the depth but is independent of width, may be designated the "critical velocity."

In order to avoid silting, the velocity must not be kept constant throughout, but must be increased with the depth. This fact is an argument against the common practice of suddenly increasing the depth of ditches to take care of deep tile outlets without providing for an increase in velocity, as under ordinary conditions the deeper section is almost certain to collect large silt deposits.

A formula to express the relation between critical velocity and depth is given by R. G. Kennedy in a paper on "The Prevention of Silt in Irrigation Canals" (*Proceedings*, Inst. C. E., Vol. CXIX). Here v is the critical velocity in feet per second, d is the corresponding depth in feet, and c and m are constants to be determined by experiment. From observations in India on canals of various sizes which have reached a permanent condition of silt equilibrium he deduced values of 0.84 for c and 0.64 for m, giving the equation as shown:

$$v = cd^m, \text{ or } v = 0.84\ d^{0.64}$$

The claim that this formula is applicable to all ditches, without regard to size or to the character of silt, is supported by E. C. Thrupp in a paper on "Scouring Power in Relation to Velocity and Depth" (*Proceedings*, Inst. C. E.,

Vol. CLXXI). Good judgment calls for further supporting investigations, but the formula may be accepted tentatively. He gives values of mean or critical velocity corresponding to different depths, as shown in the accompanying table. Information along the same lines may be found in a paper on "Prevention of Silting and Erosion of Watercourses," by S. W. Fresco1n, drainage engineer, U. S. Department of Agriculture June, 1915.

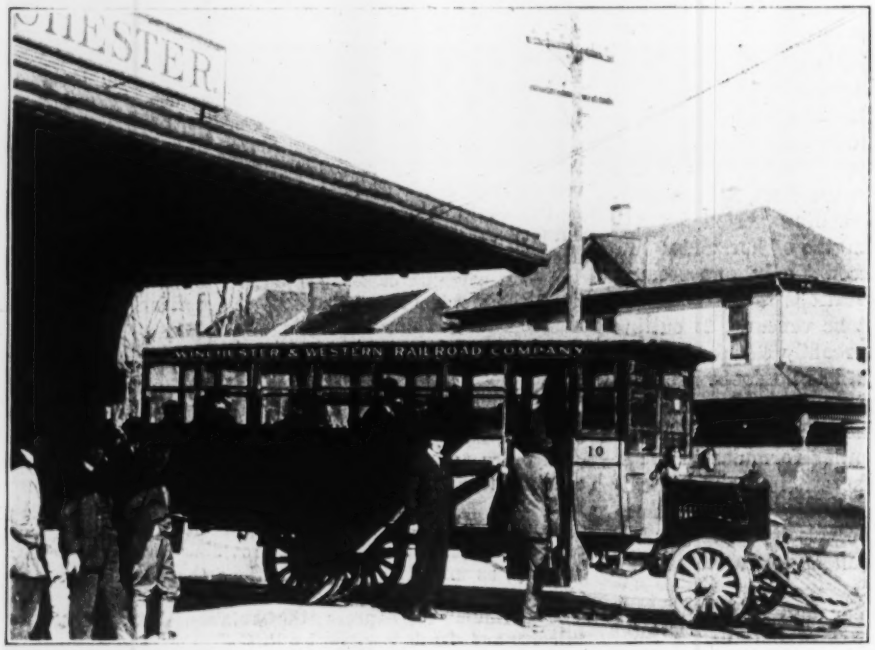
TABLE OF CRITICAL VELOCITIES FOR DITCHES

Depth	Velocity Ft. per Sec.	Depth	Velocity Ft. per Sec.	Depth	Velocity Ft. per Sec.
1 ft.	0.84	5 ft.	2.35	8 ft.	3.18
2 ft.	1.30	6 ft.	2.64	9 ft.	3.43
3 ft.	1.70	7 ft.	2.92	10 ft.	3.66
4 ft.	2.04				

After a ditch section has been determined in the ordinary way it may be tested by application of the formula. If this shows that the mean velocity is less than the critical velocity, the section may be redesigned, reducing depth of flow and increasing width so as to increase the velocity to a safe value. Then the increment in cost of this section over the ordinary section may be compared with the cost of annual dredging operations necessary to maintain the latter section.

Motor Bus Operates Successfully on Short Line Railroad

OPERATION of a motor bus in passenger service on the rails of the Winchester & Western R.R. from Winchester, Va., to Wardensville, W. Va., has proved highly successful, according to officials of the line. The distance covered is 42 miles, at a speed of 25 miles per hour, negotiating grades of 3 per cent and curves of 14 deg. The bus body is mounted on a 2½-ton truck chassis and has a capacity of 34 passengers. Flanged iron tires are used. It is now operated 84 miles per day and this schedule will be doubled when traffic warrants.



MOTOR BUS WITH FLANGED WHEELS FOR SHORT LINE PASSENGER TRAFFIC

In actual service the total cost of operation per day, covering 84 miles, is about $11. Gasoline consumption is 1 gal. per 10 miles. The car takes all grades at full speed with only partial opening of the carburetor throttle. Since the track is new, speed is now restricted to 25 miles per hour, with the intention of increasing speed as the track is improved from time to time in the near future.

A 4-ton trailer is to be added to the equipment. The front end of the trailer will seat about twelve people and the remainder of it will be used for mail, baggage and express. As soon as the traffic warrants, it is intended to make two round trips per day, covering a total distance of 168 miles, including 76 possible stops, thus affording people along the line an opportunity to come to the towns in the evening.

Bus Adapted to Rail Service

The photograph of the bus, on the rails at the Winchester station, shows the sanding equipment, including sand boxes and jets for rear driving wheels operated by the motorman. A pilot of heavy construction has been built onto the front of the car. The car is heated from the exhaust by a special register that can be cut in and out by the motorman. An ordinary automobile register was first tried, but later rejected since it caused objectionable back pressure.

Previous to operation, the question was raised whether excessive nosing motion of the car would be experienced if operated without a pony truck. Experience has shown that there is no such motion. The steel tires, which are pressed onto the truck wheels, are of standard cross-section for locomotive tires, but ½ in. extra wide and 1 in. thick.

In the opinion of the operators of the Winchester & Western R.R., the handling of passengers on a short-line country railroad, under steam operation, with mixed trains, is a liability rather than an asset. It is believed that expansion of the service now being undertaken will demonstrate that such lines, in many cases, can be operated profitably by motor.

W. B. Cornwell is president of the railroad company and personally supervised the installation. The 2½-ton truck was furnished by the Service Motor Truck Co., Wabash, Ind. The tires were pressed on the wheels by the Midvale Steel & Ordnance Co.

Activated-Sludge Plant for Shanghai

A large-scale experimental activated-sludge plant for Shanghai, China, has been authorized at a cost of about £32,000 on the recommendation of C. H. Godfrey, engineer-commissioner of public works. According to *The Surveyor* of London this project "is largely in the nature of an experiment on a larger scale than the installation in operation for eighteen months."

Terms of Port Compact Between New York and New Jersey

UNDER the terms of the port compact bills which have become law in New York and New Jersey, designated commissioners are authorized to sign a treaty or compact creating the "Port of New York Authority" and pledging the two states to "faithful co-operation" in the future development of the Port of New York. The second Port Compact Bill, now law in New Jersey but at this writing not yet enacted in New York, provides the means of appointment of the six members of the Port Authority, three from each state. The New Jersey bill names as appointees the three New Jersey members of the New York, New Jersey Port and Harbor Development Commission which has submitted a "comprehensive plan" for the development of the Port of New York, at the same time recommending that a port treaty be enacted. The second bill in New York State delegates the power of appointment of the three New York members to the Governor, with confirmation by the Senate, but provides, as does also the Compact itself, that two of them shall be resident voters of New York City.

The agreement creates the "Port of New York District" including Jamaica Bay to the east, White Plains at the north, Paterson, Summit and New Brunswick on the west, and Sandy Hook on the south (see comprehensive plan of bi-state commission, *Engineering News-Record*, Feb. 10, 1921, p. 271). The Port Authority shall have power to purchase, construct, lease or operate any terminal or transportation facility within the port district and such additional powers as may later be conferred upon it by the two legislatures or by act of Congress. However, under powers now delegated by the agreement, no property shall be taken by the Port Authority without the consent of the state, county, or municipality where located, nor shall the powers of any municipality to develop port and terminal facilities be impaired.

All the foregoing powers may not be exercised by the Port Authority until the legislatures of both states shall have approved a "comprehensive plan" for the development of the port and either state may withdraw from the compact if such a plan is not adopted by both states before July 1, 1923. The second bill states that the Port Authority shall report to the two legislatures before Jan. 1, 1922, the results of studies, investigations and public hearings, which it is charged to conduct previous to that time, and shall submit a "Comprehensive Plan for the Development of the Port District" based upon such results. As soon as practicable the legislatures of the two states shall adopt plans for the development of the port, according to the compact.

From time to time the Port Authority will make plans for development and submit them as recommendations to the legislatures of the two states or to Congress. When adopted by the legislatures such plans shall be binding with the same force as if incorporated in the treaty.

The Port Authority is authorized to petition any governmental body in matters of transportation development of the port and "it may intervene in any proceeding affecting the commerce of the port."

Each state obligates itself only to an expenditure of $100,000 per year until revenues from operations conducted by the Port Authority are adequate to meet all expenditures. The Port Authority shall not pledge the credit of either state, except by authority of its legislature.

In addition to outlining the terms of the Port Compact, the first bill in each state authorizes the commissioners signing it to obtain the approval of Congress.

The second bill, providing for the appointment of members of the Port Authority in each state, appropriates the sum of $100,000 for the expenses of the Port Authority. In New Jersey the power of appointment is vested with the Senate of the Legislature. In New York this power is delegated to the Governor. The members are charged with the duty of taking up and studying the joint report of the New York, New Jersey Port and Harbor Development Commission and "more especially the recommendations contained therein," conducting investigations and public hearings. Terms of office of the three New York members of the Port Authority expire July 1, 1924, 1926 and 1928, and terms of the three New Jersey members expire as follows: J. Spencer Smith, July 1, 1923; De Witt Van Buskirk, 1924; Frank R. Ford, 1925. However, each member shall hold office until his successor has been appointed or qualified.

L'Enfant, a Tribute to City Planner

THE Digges-L'Enfant-Morgan papers on the beginnings of our National Capital have been added to the Library of Congress by bequest of Dr. J. Morgan. The following tribute to L'Enfant, with some information regarding the papers, taken from the Report of the Librarian of Congress for the year 1919-20, will be of interest to engineers and city planners:

Pierre Charles L'Enfant was born in or near Paris in 1754. With other young French officers he came to this country to fight in the Revolution; he was severely wounded while leading an attack on Savannah and later was captured at Charleston. He was known personally and as an engineer by Washington, Lafayette, and the French officers; after peace came, L'Enfant altered the New York City Hall and designed a house for Robert Morris in Philadelphia; and when Congress entrusted to President Washington the task of planning the permanent capital, L'Enfant applied to be appointed and was entrusted with the work. He brought to his task a first-hand knowledge of the plan of the royal city of Versailles, a comprehensive grasp of the elements that go to make up a seat of government, and an imagination which a century and a quarter of unprecedented national growth has not outstripped. His plan is the basis of all that is noble in the design of Washington, and also the guide for future development. Hence the papers that embody his ideals have an increasing significance as the City of Washington develops as one of the great capitals of the world. If struggles with landowners and speculators exasperated George Washington, it was to be expected that the high-spirited French visionary, whose lively imagination saw beyond today, would go down before them. He did no great work after 1792; yet he lived until 1825, and his tall, well-proportioned figure, arrayed in bell-crowned hat, long coat, and knee breeches, was daily seen making its way over the stump-strewn streets of the new capital which he designed but for which others were getting the credit.

During his last year L'Enfant—proud, penniless, but always a gentleman—found a home first with his bachelor friend, Dudley Digges, of Warburton (near Fort Washington), and after the death of Mr. Digges with his nephew, William Dudley Digges, of Green Hill, Md., just beyond the District line. From this grandfather, Dr. James Dudley Morgan inherited the papers left by L'Enfant, and to them he added many others gathered during the long years he spent in bringing about the removal of L'Enfant's body from its obscure burial place on the Digges estate and its interment at Arlington, after imposing ceremonies in the Capitol.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

Reasons Advanced Against Laws Requiring Registration of Engineers

Sir—On March 30, at the request of President Aertsen, of the Engineers' Club of Philadelphia, I appeared before the Pennsylvania House Ways and Means Committee at Harrisburg as a member of a delegation from the club in connection with House Bill 204, providing for the registration of professional engineers and land surveyors.

The club having expressed itself through criticisms which had been embodied in amendments suggested to the committee, I was left to address the committee as an uninstructed individual. As I had not seen the bill until late on the preceding afternoon, I was uninstructed in more senses than one.

Ostensibly the object of the bill is "to safeguard life, health and property." I expressed the conviction that not only that particular bill, but registration in general, is unnecessary and impotent to that end. I submitted that engineering works of sufficient magnitude to menace life, health and property to an extent calling for special legislation were usually in the hands either of governmental departments or of capitalists who, in their own interest, would employ only engineers who could easily pass the examinations which the proposed registration commission would be likely to set up.

As notable cases where engineering operations had wrought large-scale injury to life, health or property—injury which a registration act would not have prevented—I mentioned (1) the collapse of the Quebec bridge, whose engineers would easily have qualified under any probable registration commission, and (2) the cave-ins of Scranton, Pa., over coal mines whose pillars had been robbed to such an extent as to cause the disaster, a disaster which would probably have occurred in spite of the pending bill, if it had been in force.

I submitted that the safeguarding of life, health and property might be more simply and more effectively accomplished by so heavily penalizing those responsible for accidents as to render the accidents improbable. Of course, I pointed out (although idly, under the circumstances) the absurdity of tolerating 48 different registration acts, passed by as many little sovereign states, for the hamstringing of engineers and for the emolument of their brethren of the legal profession.

I left the committee room better instructed than when I entered it. My instruction came through the arguments of the gentlemen (mostly or all not of the Philadelphia Engineers' Club) who spoke in unqualified support of registration. These arguments showed me that, in speaking of the ostensible object of the bill (the safeguarding of life, health and property), I had been merely beating the air, that the primary object of registration is the transformation of engineering from a profession into what Dr. Herbert Snow, addressing the committee, aptly called a "craft," and that what its supporters primarily desire is that the State of Pennsylvania shall erect about certain members of our common profession a protective barrage, through which other members shall not be able to penetrate.

There is a suggestion of "craft" in the urging of registration as being primarily for the safeguarding of life, health and property. The arguments advanced before the committee in favor of the registration of engineers left me, more than ever, a free-trader.

JOHN C. TRAUTWINE, JR.,
Philadelphia, April 2. Civil Engineer.

Professional Engineering Laws vs. "License Laws"

Sir—In the open letter from a consulting engineer of Springfield, Mass., in *Engineering News-Record* of March 31, p. 565, under the title "Does Licensing Make for Responsibility," objection is taken to statements in a recent editorial of yours on the subject; and the statement is made that "license laws . . . so far as I have been able to determine, have never accomplished anything except bothering competent engineers."

The unfortunate part about the acts which regulate engineering practice is that they are so frequently termed "license laws," probably due to the fact that the pioneers in the movement were not careful enough in the selection of the title to designate the purposes of the act instead of the method of enforcing. To an engineer jealous of his vocation the term license is objectionable, but should not be so when considered in its proper meaning of "liberty to do." The term "registration" is equally objectionable in the idea conveyed as to freedom or liberty to do as one pleases. Requirements of registration and licensing are merely means to the end and it is extremely unfortunate that the laws have come to be known by these names.

In all states the practice of law, medicine, dentistry, and other vocations affecting life, health and property, is controlled by law. There are violations of the law and always will be.

These do not vitiate it, but are rather the exceptions that prove the rule. In only fourteen of the forty-eight states have laws been enacted to control the practice of professional engineering and to protect professional engineers.

To the advocates of engineering practice acts this thought stands out in bold relief: Work which is fundamentally that of the professional engineer should be, by law, required to be done by properly qualified engineers; the engineer should be registered and the practice of professional engineering controlled by license. The public pays; the public should be protected.

The engineer should always be encouraged and protected in his vocation that he may better serve his country, his state and mankind.

Those who practise in different states may be inconvenienced at times, but must forget their personal selfishness and realize that such laws are for the greatest good of the many.

It seems like a propitious time to change the names of these laws from the misnomers of "engineers' license law," "engineers' registration law," etc., to something that will more nearly designate the purport and which will at the same time add dignity and prestige to the profession, such as "professional engineering practice law," or "professional engineering law."

GEORGE L. BEAN.
Philadelphia, April 5.

How Shall Engineering Practice Be Limited?

Sir—How will you fairly shut off practice by an "engineering corporation"—and also shut off practice by a single engineer who runs an outfit just as large?

Many engineers operate a large staff of engineers and non-engineer assistants. I consider New York Senate Bill 147 based upon selfish motives and hence unwise. It will cost the taxpayers more money and favor a certain class, which is dangerous.

LOUIS E. BUFF.
Jamaica Plains, Mass., Apr. 6.

[The issue is not one of size, but of legal classing among engineers those who have no engineering qualifications. To do that would not only destroy a possible professional status before the law, but would negative the fundamental purpose of the licensing act, which is to restrict engineering practice to qualified engineers. The issue will be found more fully stated in *Engineering News-Record* of April 7, p. 577.—EDITOR.]

The Antioch Plan

Sir—I have been very much interested in the articles and letters appearing from time to time in reference to the Antioch plan, especially those written by Mr. Morgan and Mr. Morrison.

The conception of Mr. Morgan, in many respects, is a new departure in American education and the plan which has evidently been carefully formulated reminds one of some of the outstanding aims of the German *gymnasia* and *real schulen* of pre-war days in that it apparently contemplates providing training for a selected group of presumably superior intelligence. It is difficult to add to the plan or to make constructive criticism of it. The idea should increase the respect which engineers already hold for Mr. Morgan because of his achievements as one of them.

It is not clear to me, however, that such a plan is fully applicable to the conditions governing state institutions. In these, it is not possible to make a careful selection of student material since entrance to them is not limited to those of super-average ability. As a result the enrolled student body is made up of a relatively large number of those having average ability and smaller and about equal numbers of those having in the one case super-, and in the other sub-average intelligence.

In Mr. Morrison's letter, *Engineering News-Record*, Feb. 24, 1921, p. 349, there is much excellent criticism of our present educational organizations and methods, but also several statements with which many educators will not agree.

While "the average engineering student never has a thought of anything but a good technical job," isn't the answer to be found in the word "average"? Isn't it a general rule that the leaders in business, industry and other human activities are those of superior ability or intelligence? Training men for subordinate positions is not the aim of faculties of engineering of which I have knowledge; if it is, they have failed signally with their brightest students. Certainly, the young engineer must first serve as an assistant until he has acquired experience and judgment.

I am very reluctant to believe that it is the general opinion that the main object of an engineering course is "to shoot the student full of facts, and knowledge, and methods." I do not believe that this aim is that of a large majority of engineering or of general educators. Rather, I am inclined to believe that they seek to train the young (1) in developing and maintaining a healthy body; (2) in perfecting them in the use of the mother tongue; (3) in preparing them to be self-supporting; (4) in preparing them to be good active citizens; (5) in spiritual matters, and (6) for the proper enjoyment of leisure.

Since a large part of engineering education falls under (3) above, it is not easy to compile a curriculum which will not contain a certain amount of narrowness. The time for the mastery of the fundamentals of engineering and business is, after all, so short that but little remains for training designated under the other heads, though a first rate educational organization will avail itself of every opportunity to direct attention to and emphasize the importance of these aims.

Such subjects as algebra, analytical geometry and calculus are surely not as useless as Mr. Morrison believes. There is nothing in engineering that cannot be worked out by arithmetic if one but lives long enough to do the work that way. If graduates in engineering do not recognize the opportunity for time saving in the use of higher mathematics, the blame cannot be placed upon the subject.

Mr. Morrison's reference to the resemblance between the present day college and an automobile factory is certainly true and very amusing, although the automobile factories usually operate in summer. A course in engineering does not consist of so many credits which make a grand total. It is a four- or five-year course made up of subjects which should be closely correlated. The entire curriculum should be carefully considered in detail and the sequence of courses with overlapping and repetition, to emphasize the fundamental principles, should be carefully planned.

I agree heartily with the statement that training in etiquette should be provided—perhaps by confidential heart to heart talks with the classes, by correction whenever necessary, and at all times when conditions are right for driving home such points.

In the course in Civil Engineering given at the Oregon Agricultural College it is the aim to develop character and appreciation, and to make the students as expert as possible in the fundamental subjects in engineering; to provide training in the fundamental principles of business, and government; to provide practice in the use of both oral and written English by means other than those furnished in formal English classes, and to provide training in scientific and efficient methods of analyzing, computing, and recording data. Attention is also given to the necessity of doing one's part in local, state and national movements whenever possible. The attitude of the students in this work is most gratifying. They seem to be very enthusiastic and alert.

It is to be regretted that more engineers do not, as Mr. Morrison has done, offer constructive criticism on educational matters. The national engineering societies have not taken the active interest in engineering schools that they should. They could and should do for engineering colleges what the American Medical Association has done for schools of medicine.

STUART SIMS,
Head, Department of Civil Engineering
Oregon Agricultural College.
Corvallis, Oregon, March 21.

Pin Tests Open to Question

Sir—The article "Higher Stresses for Bridge Pins," in *Engineering News-Record* of Mar. 24, p. 502, seems to demand some comment.

Partial test data are given for bending tests on wrought-iron and steel "pins." For one set characterized as "comparatively short" cylindrical beams the ratios of length to diameter range from about 6 to about 16; for another set 8 to 16; and another 2 to about 10. Certainly it is going far to characterize a beam, the maximum depth of which is $\frac{1}{8}$ the span length, as a short beam or as a pin. This point is brought out to show that so far as the ratio of length to depth is concerned, the test specimens would appear to have been in most cases ordinary, or comparatively long, beams.

No information whatever is given as to the methods of the tests in the very important features of kind and character of supports, point of application of load, and method of determining elastic limit and ultimate strength.

Referring to the diagrams, I can see no justification for suggesting that the elastic-limit points lie on inclined lines. To my eyes they show moderately small deviations from horizontal lines, which is in accordance with our accepted theory of the strength of beams. The elastic limits, however, being double those obtained in tensile tests, certainly seem open to suspicion, either that there was something wrong with the test data or derivations, or that our theory of the strength of beams is entirely wrong. It is noted that elastic limits are not shown for the Watertown Arsenal tests. It is, of course, well known and explained by theory that the ultimate strength of such beams is greater than indicated by the theory which applies within the elastic limit, although it is necessary to define what is meant by ultimate strength. In the case of wrought-iron and structural steel beams of this form there should be no such thing as *rupture* from such tests.

The author's explanations of the high stresses confuse the tests with the general case of pins in structures and do not seem to satisfy regarding the abnormal elastic limits shown.

In view of the above I believe it must be generally agreed that there is much to be explained in the test data before they can be accepted either as sustaining the author's deductions or, what is more important, as upsetting the established theory of flexure. The tests should be further investigated, and it is hoped that the author will do so and publish in your columns all the additional information possible to aid in checking the data furnished and their application to practical use.

In the determination of the strength of pins in bridges there has always been the great difficulty of determining the true bending stresses. As ordinarily figured these stresses have been found extremely high without visible signs of overstress as noted by the author of the article. The prevailing thought among bridge engineers has been that the stresses have not existed, but were merely fictitious results of erroneous methods of figuring. There are some cases, however, where the packing of pins is not close and it is certain that the bending stress can be closely approximated by theoretical computation. If the stress is too high, especially if the elastic limit is exceeded, it may be the cause of changing the distribution of the loading among the members connected and thus causing overstrain in some of them.

A. W. CARPENTER,
New York City, Apr. 4. New York Central R.R.

Rammed Earth as a Building Material

Sir—I was interested in the article in *Engineering News-Record* Feb. 10, p. 267, on the use of rammed earth as masonry in building construction. The author of the article writes as though the idea is new. In fact it is one of the most ancient methods of wall construction. I have run across such buildings in China, Japan, Egypt and France, some of them having been standing for centuries.

Early in 1917 I was sent to France on a mission which led to the making of a careful study of building methods there. On the first trip to the devastated regions I was struck with the complete demolition of buildings by shells. It seemed odd that stone buildings should have fallen into heaps and that two years' rain made them assume the appearance of heaps of dirt with stones sticking out here and there. On examination I found that the majority of stone buildings had been laid up in clay mortar; and that the joints had been raked, only an inch or so in depth of the face of each joint consisting of regular lime or cement mortar.

I discovered hundreds of buildings constructed of rammed clay. Some had heavy wooden frames, like our well-known half-timber construction, the interstices of which were filled with tamped clay. I also observed natives erecting new houses with this material, which is known as *pisé*. Some of the houses were made of tamped clay containing considerable grass and straw, while others were entirely free of all vegetable matter. Over the face of each wall was laid a thick plaster coat of lime, or cement mortar for protection against the rain.

From *La Construction Moderne Pratique*, by Henry Guedy, architect, and consultant to the council of the prefecture of the Seine, published in Paris, the following paragraphs are taken, to illustrate the knowledge French builders have of the material.

Pisé is a method of building with earth which is even more simple than building with hollow tile. This economical method forms solid structures proof against fires. Whenever walls of pisé are well made they consist of but one piece, and when covered with a good coat of mortar they will last several centuries provided they are not exposed to moisture. This mode of construction is employed only in those localities where stone is hard to find, and then only for structures of no great importance.

All earths which are neither too fat nor too lean may be used for the making of pisé. The best is a clear earth with a little gravel, for it will hold together in a ball while being put into the wall and it is necessary to break it to get it out. To prepare the earth it is necessary to crush it and then put it through a screen of average size to take out stones larger in size than a nut. If the earth is too dry it is moistened by sprinkling.

One may also make a mixture of clay and sand, with clear earth in the following proportions: (1) 4 parts clay, 1 part of sand, 1 part of small gravel; (2) 2 parts clay, 1 part sand, 2 parts vegetable earth; or (3) 1 part clay, 1 part small gravel, 2 parts vegetable earth.

In many departments there is added to these mixtures, by kneading into them, some straw or hay to prevent fissures in the construction when it dries out.

Walls of pisé are made in two ways: (1) By depositing the mixture of earth and straw in positions determined by stretching cords; (2) by placing the masonry between two panels about 2 meters x 0.80 meter, held in position at a distance equal to the thickness of the wall. Between these plates the pisé is placed in well-tamped layers. When one level is filled the supports are withdrawn and the box is replaced for the next layer. The holes left in the wall by the pieces connecting the wall forms are filled with the earth.

A coating formed of 1 part of lime to 4 parts of clay and sufficient hair to bind the mass well together makes the pisé resistant to the action of air and rain. This coating should not be applied until the wall is very dry; the drier it is the better the coating adheres. A coating of plaster may also be used. No matter how well the coating is applied this style of construction is very susceptible to absorption of moisture. The walls should have a foundation of brick or stone.

I noticed at Abainville a number of buildings of pisé constructed by our men for use as barracks, etc. Such construction was used at other points as well. Coming back to our own country I ran across tamped earth buildings in the western part of Kansas, in Idaho and in California built by early homesteaders. Remains of such structures may be found today near the more prosperous appearing farmhouses which succeeded them.

FORMER LIEUTENANT-COLONEL, A. E. F.
New York, Feb. 12.

Too Great Concern Over Sea Water Concrete

Sir—The article in *Engineering News-Record*, Jan. 20, 1921, entitled "More Observations of the Effect of Sea Water on Concrete" provokes the complaint that a great deal is being written on this subject with very insufficient and often without any reliable data as to the quality of the concrete which is deteriorating so rapidly in the presence of sea water.

The author of "More Observations" keeps assuring us that the concrete he examined had every appearance of being the very best or as good as could be expected under ordinary inspection. He sits as judge and jury and condemns concrete generally on the visual evidence, while he admits that "no attempt was made to trace the history or learn the precise design of the structure."

The failure of concrete structures is by no means confined to the sea coast. Many more millions of dollars have vanished in failures than are represented by the concrete structures on the Pacific Coast and many are the millions involved in steel structures that have failed, to say nothing of stone and brick that have failed as ignominiously. The reports of these failures add very little to our knowledge and do little toward preventing a recurrence of such failures, unless they are accompanied by detailed information as to the sufficiency of design, quality of materials, workmanship and supervision.

The Pacific Coast piers mentioned are, with one exception, pleasure piers built by development companies in about the same manner as all such structures have been built for these companies the country over. They all look woefully alike a year after they have served the purpose for which they were built.

The only pier mentioned which could serve as a criterion as to what to expect from properly made concrete in the presence of sea water, has been dismissed with the observation that while it did not show signs of disintegration, this was probably due to the presence of a coating of scum from the oil floating in the harbor which no doubt acted as a protection. This certainly suggests a very cheap method of overcoming the difficulty, if a coating of oil is all that is needed.

The truth of the matter is that if we take, out of stock, cement of dubious origin, waive inspection, mix it with sand varying in quality from broken shell to disintegrated feldspar and broken stone, which may range in fitness from marl to mica schist, whirl it once or twice round in a mixer with water from the handiest source added until the mass is soupy enough to satisfy the foreman, and then dump it into leaky forms with little or no spading, we will have a concrete which cannot be expected to stand up under any circumstances, in sea water or out. The commission of all of these offences is by no means absolutely necessary to account for the conditions observed on the Pacific Coast. One or two are amply sufficient.

The San Pedro piers were designed and built under the supervision of the municipal engineers of Los Angeles. The plans and specifications were carefully prepared and their intent secured by proper inspection from the time the cement was being manufactured until the forms were removed from the finished concrete. Some of these piers in the Outer Harbor have been in place since 1914 and it would be interesting to hear from those who are now responsible for their maintainence just how this concrete is being af-

fected by its exposure. It would also be interesting to know whether the choice of creosoted wooden piles for the Santa Monica pier took into account the well-known appetite of the Pacific teredo for creosoted lumber.

A cement, whose manufacture, according to standard specifications, is assured by sufficient inspection and testing, with a fairly clean siliceous sand, clean, hard and sound gravel or broken stone, mixed in the proportion of 1:2:4 for at least 1½ minutes in a power driven mixer, with just enough water to make a free flowing velvety mass, placed in tight forms and thoroughly puddled with spades or rods, and then wet down periodically for a week after it has set, will produce a concrete which need cause no anxiety, though exposed to sea water. If the concrete is reinforced with steel, this should be so placed and held in the forms that none of the metal or its fastenings shall come within 1½ in. of the finished surface.

In the case of concrete piles, the reinforcing should be sufficient to amply provide for the bending strains developed in handling. These should cure on shore for four weeks before they are put in the water, and if cast in tiers, should be so supported as not to be subject to bending while green.

Concrete piles should be jetted, or jetted and churned down, in hard material. In fairly soft material, a steam hammer may be used, if a cushion block is inserted between the pile and the hammer. The steam hammer is also useful in bringing a jetted or churned pile to firm bearing. A drop hammer should never be used on a concrete pile. Overdriving, a frequent source of failure, should be carefully avoided.

It is not the purpose of this communication to suggest remedies for the defects observed in concrete, but rather to impress on those who write concerning these defects the need for furnishing sufficient data to enable us to avoid materials and methods which have been found to be pernicious and detrimental to good results. F. J. LITTER.

New York, March 31. Chief Engineer, Snare & Triest Co.

[Mr. Litter reads into the article much that was not in the mind of the writer. Concrete is not condemned generally nor was lack of historical data concerning the structure concealed. It may be that all of these Southern California piers were built of poor material and with poor methods, (though they are by no means all "built by development companies") and a complete study of their condition would require that such investigation be made. But the article in question was frankly only "some observations" of the effect of sea water on concrete which, whatever its antecedents, had superficial integrity. That reinforced concrete which appears to be good can so rapidly break down in sea water is, to our mind, useful information.

It is not quite fair to say that there are plenty of similar failures in inland concrete, for this particular type of failure is peculiar to sea water reinforced concrete. Nowhere else appear the hair cracks over reinforcement, progressing through well defined stages of discoloration and rusting to ultimate breakdown, while the main body of the concrete remains solid and unimpaired. In this type of failure there is no evidence of submission of the concrete itself to sea-water attack. It is merely that there is sufficient porous admission of corrosive salts to the steel to cause rupture of the concrete from expanding rust. Obviously, better—which is denser—concrete will resist such porous admission, but such a remedy is only qualitative and all observations of existing structures show that it is one whose effectiveness is by no means assured. Some rules—as quoted in Mr. Litter's letter—say that it is possible to make the concrete so dense that the salts cannot get beyond 1½ in.; others go so far as 3 in. But if the salts can go ½ in. (and they must go that far, in the minds of the makers of such rules, or else the minimum covering would be made less), why cannot they go farther? The material is homogeneous except for a thin surface skin.

In other words, the problem of sea-water reinforced concrete is not to be solved by generalities regarding good concrete. Much work is yet to be done and many more structures studied comprehensively. In this latter contention we are in complete accord with Mr. Litter.—EDITOR.]

Useful Dodges in Surveying

Sir—Some of the statements embodied in Mr. Thackwell's letter in your issue of Feb. 17, p. 313, are so sweeping in character that they should not go unchallenged. I note, with pleasure, that he has specified some fundamental conditions governing map work, but he has not gone far enough. In addition to his "scale, contour interval and topography," I would mention *quality*.

Usually the scale that will best fit the intended use of the map is determined first and then a contour interval is selected. Theoretically this interval should be selected so as most accurately and consistently to portray the terrain. In practice, however, the ideal relation of scale and interval is often not considered. To say it is never advisable to construct a map on a scale of, say, 400 ft. equal 1 in. with a contour interval of 10 ft., where an accurate representation of the terrain would require an interval of 2.5 ft., is too broad an assertion. There may be instances where a "picture map" upon some specified scale is all that is required. Such a map, however, could hardly be called a topographic survey. Why not make such a picture map upon a scale of 1,000 ft. equal 1 in. with the 10-ft. contour interval? Then with the same expenditure of money a map would be consistent—that is, no accuracy would be indicated which was not inherent in the map.

One of the controlling factors in mapping comparisons, which Mr. Thackwell mentions, is topography. I must take exception to his statements that the "mapped area was a fairly rough section," and "the distance between shots should average a distance in feet equal to the scale of the map in feet per inch." Both of these things may be true in any particular case, but the distance between shots is not a function of the scale alone, but is dependent upon the frequency with which critical points or breaks in the ground surface occur. This distribution and frequency of critical points is best described by the term "texture"; the area referred to, doubtless, was of coarse texture. Aside from the relative advantages of the plane-table or transit there is no room for debate upon this question: The distance between shots should *not* average a distance in feet equal to the scale of the map in feet per inch for any or all types and textures of topography, unless a picture map is all that is being constructed.

It is difficult to define exactly what constitutes a good—or the best—topographic map. It should be defined in some way, however, before comparisons as to methods and speed are entered into. In general, a map that, upon actual test, shows an average vertical error greater than the contour interval should either have a larger interval or be made over again. There should be a balance between the field procedure and the results obtained which would insure that the average error in the horizontal or geographic position of points should not greatly exceed the smallest distance which can be plotted upon the given scale. I believe that the average vertical error should not exceed half the contour interval and that the horizontal error should *in no case* exceed twice the smallest plotting division and should, *in the average*, be within one division.

It should be borne in mind that the map Mr. Thackwell discusses is a map of a particular type of country and his conclusions as to the best methods can only apply to that same general type of country. No definite statements are made as to accuracy. I assume that it was of sufficient accuracy to fully serve his purposes, but it would even be hardly fair to assume from that, in the absence of any such definite statements, that it would serve every other use equally well.

Regarding methods I am of the opinion that if any combined method is to be followed it would be better to flatten out the top of the "easel" (thus making it a plane-table) and in place of a protractor use a small sight alidade with a compass attached, eliminating thereby the useless reading and setting off of the horizontal angle with its two chances of error; also place the topographer at the table and the recorder at the transit. This combined method is suited to all types of topography where the contour sketching is light enough, so that a skilled topographer can keep up with the instrument man's shots. It is the speediest

method known, but the unit cost will generally be no lower than that obtained by a trained topographer using a plane table, *no* recorder, and two or more rodmen. Therefore, where the area to be surveyed is uniformly light sketching, use the combined method, transit and plane table. Where it is for any considerable portion heavy enough to justify the reading of many vertical angles and the use of a recorder, use the regular plane table party of topographer, recorder and one or more rodmen; and in the light portions, where the recorder is not necessary, hand the recorder a rod.

In support of the plane-table method as herein advocated I quote the following examples with which I am personally familiar and the complete facts regarding which are matters of record:

In the course of the topographic survey of Flint, Mich., now being made (see *Engineering News-Record*, April 8, 1920, p. 700), the record progress for a day's work by one plane table party was 194 acres in 8 hours. This survey is on a scale of 1 in. equal 200 ft. and a contour interval of 1 ft. The area covered was in the outskirts of the city, and was fairly level farming land. One main road ran through it, with its consequent ditches, private drive crossings, culverts, etc., and included in the area were fields of corn and some timber. The party consisted of a topographer, a recorder, and two rodmen. The number of shots was 746, or 3.8 per acre and the cost per acre was approximately 13 cents.

The record day's work on the topographic survey of Lucas County, Ohio, was 280 acres, the party consisting of a topographer and two rodmen, the scale 1 in. equal 400 ft., and the contour interval 1 and 2 ft. This area was very similar to the Flint area mentioned above in respect to the type of topography, visibility, etc., and is on the outskirts of the city of Toledo. The cost per acre of this day's work was slightly over 6 cents. As to the accuracy of these surveys, reference is made to the account of the Flint survey above mentioned and to the table given below.

Survey	Scale	Contour Interval	Length of Profile	Relief	Number Points Tested	Average Error per Point
Dayton, O.	1:2400	1	3162 ft.	51 ft.	50	0.55 ft.
Jackson, Mich.	1:2400	1	3150 ft.	38 ft.	52	0.53 ft.
Lucas Co., O.	1:4800	1, 2	8035 ft.	26 ft.	105	0.41 ft.
Flint, Mich.	1:2400	1	6423 ft.	30 ft.	130	0.26 ft.
Akron, O.	1:2400	1, 2, 4	2851 ft.	70 ft.	41	0.47 ft.

I do not agree with Mr. Thackwell, and in answer to his attack upon the plane-table method I can say that I have never known the transit to win out in competition with the plane-table method, but have repeatedly known it to fail in side-by-side comparisons; that the combined plane-table and transit method recommended herein is essentially a plane-table method and is fully equal, if not superior in speed and excellence of results, to the method described in his letter and for use in the type of country with which he has to deal; that in topography that is rougher or finer textured the regular plane-table method in the hands of a trained topographer will make a better map for the same money than his method; that regardless as to whether or not "expressive delineating" is ever inaccurate, it is not within my knowledge that a "wooden" map ever made for accuracy. In short, while I have no desire to detract from Mr. Thackwell's work or to imply that it was in any way any thing else than entirely satisfactory for the purposes for which he made his maps, I take exception to all his claims of exclusive superiority for his method and to his arraignment of the plane table.

The plane-table method, used by a trained topographer, is for all scales and in the vast majority of cases the best means yet discovered for really accurate topographic mapping.

G. D. WHITMORE,
Topographic Engineer, R. H. Randall & Co.

Akron, Ohio,
March 4.

Sir—I have been very much interested in Mr. Thackwell's further explanation of the method he uses in making topographic maps as published in your issue of Feb. 17, p. 313. Engineers, especially the younger men, who are interested in topographic work, are entitled to statements of fact rather than to differences of opinion in regard to the comparative merits of various methods. Since Mr. Thackwell states that "in no case would the Survey use a 1 ft. contour in connection with a scale of 1:24,000," I feel that it is right that topographers should know that the U. S. Geological Survey has adopted precisely the contour interval and scale he mentions. During 1915 and 1916 the Survey mapped Harris County, Texas, on a field scale of 1:24,000, using a 1-ft. contour interval. The resulting maps are published on a scale of 1:31,680. The following quadrangles are some of those now available to those interested—Deepwater, Seabrook, Crosby, Hillendahl, LaPorte.

On my topographic work in Montana, Arizona and elsewhere in the West where I have seen maps which were made by transit and stadia methods, I am convinced that often 30 per cent of the shots taken were wasted and meant nothing either to the project or in making the map. Such waste will continue as long as the fundamental conception of a contour line is that it is a line joining points of equal elevation. When engineers realize that such a definition is not precise and will base their work on the fact that a contour line is a line each point of which has the same elevation, we will have maps made by real topographers who will insist on intelligent control of the rodmen in fixing the critical points of the master lines of the ground.

Further facts in relation to topographic scales to illustrate foreign practice are given in the following table. Comparison of vertical intervals is brought to a common term (the 1-in. scale) by multiplying the contour interval in feet by the scale in inches to the mile.

France 1:50000	32
France 1:80000	52
Great Britain, Ordnance Survey, 1 in.	50
Great Britain, Ordnance Survey, Colonial	50
Great Britain, Ordnance Survey, 1 in.	100
Great Britain, India, 1 in.	50
Great Britain, South Africa, 1:125000	50
Germany, 1:200000	20
Germany, 1:250000	8
Germany, Prussia, 1:25000	41
Germany, Bavaria, 1:25000	81
Italy, 1:50000	20
Italy, 1:100000	101
Spain, 1:50000	81
Mean	49

From this table the following rule may be deduced: The contour interval in feet is found by dividing 50 by the number of inches to a mile in the scale.

Switzerland is an exceptional case where, on account of the mountainous character of the country, hill features are seldom shown by contours alone but by a combination of contours and hill shading. The following intervals are in use there: For the 1:25,000 map, 10 meters; for the 1:50,000 map, 30 meters.

In the United States, the rule in most general use to find the proper contour interval for any scale is to divide 60 by the number of inches to a mile in the scale. While these rules will not always apply to any area it is believed they will be helpful to topographers. Mr. Thackwell and I are certainly in agreement on at least one point, and that is a common pride in good topographic work.

L. B. ROBERTS,
New York Water Power Investigation.

New York City,
March 14.

Current American Shipbuilding

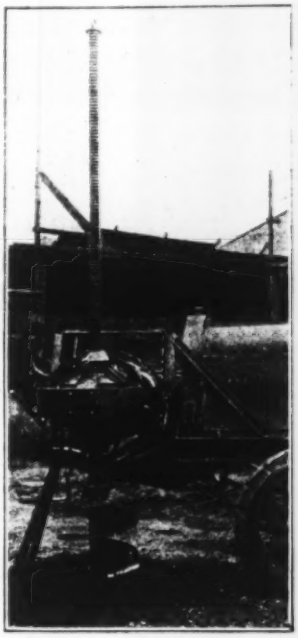
On March 1, 1921, private American shipyards were building, or were under contract to build, for private shipowners 227 steel vessels, of 901,229 gross tons, compared with 252 steel vessels, of 977,903 gross tons on Feb. 1, 1921. The shipyards have reported no new contracts during February. These figures do not include Government ships or ships building or contracted for by the United States Shipping Board.—*Commerce Reports.*

HINTS FOR THE CONTRACTOR

Earth Auger Attached to Motor Truck Speeds Hole Digging

By MARSHALL GARLINGER
San Francisco, Cal.

IN 1914, when the first transcontinental telephone line was being constructed, there arose the necessity of an improved method of boring holes for poles. A power-driven auger, mounted on the rear end of a horse-drawn wagon, was purchased and put into use. The machine was driven by a four-cylinder gasoline engine and required a team of four horses to draw it. The difficulties experienced in moving this outfit and in spotting the boring machine over the points where holes were to be dug resulted in the invention by two officials of the Pacific Telephone and Telegraph Co., Motor Vehicle Department, of the device herein described.



AUGUR BORES SIX-FOOT HOLE IN SEVEN MINUTES

The earth-boring machine which is photographically reproduced herewith is mounted on the front end of the chassis of a motor truck. Because of the rough country usually encountered a four-wheel drive truck was found to give the best results.

The mounting of the boring machine is such that it is possible to bore a vertical hole with the truck on any negotiable grade, and it is also possible to bore a hole at any angle up to 45 deg. from the vertical with the truck on the level.

The machine is driven through a universal shaft from the power take-off of the truck transmission. Since there are four speeds and a reverse in the truck transmission the earth-boring machine may be driven at a wide range of speed, thus adapting it for work in soils of different nature, such as adobe, clay, sand, hardpan, etc.

The controls of the machine and that of a derrick situated in the middle of the truck for pole handling are within easy reach of the truck driver. Inasmuch as the left-hand drive on automobile trucks is almost general the auger of the boring machine is placed on the left-hand side of the truck in plain view of the driver.

The driver spots the point of the auger on the surveyor's stake and sets the brakes on the truck, shifts the compound gear of the truck to neutral and pulls in the clutch on the earth-boring machine. The auger is fed mechanically or by gravity. In boring the speed of the auger is usually such that the earth is thrown clear of the hole. A hole 6 ft. deep, 22 in. in diameter, can be bored on an average of 7 minutes, considering all classes of soil.

The cutting edges of the auger, which are replaceable, are two in number, placed at an angle such as is found in a standard twist drill. A feature incorporated in the auger gearing is the immediate and automatic reverse of the auger speed in case the auger strikes a hidden obstruction. This precludes the possibility of any injury to the driving mechanism.

Salvaging Used Bricks With Pneumatic Chipper Tool

A PROMINENT engineering construction company recently adopted a method of salvaging old bricks whereby it was enabled to clean 3,000 brick per day at a saving of 75 per cent in cost over the previous average of 650 brick per day by hand. The work was done with a Boyer chipping hammer made by the Chicago Pneumatic Tool Co., and fitted with extra wide-faced chisels forged from stock blanks. The bricks were more uniformly cleaned than was possible with ordinary unskilled labor, and the number cleaned per day was nearly five times that of former hand methods. The blows delivered by the hammers were not heavy enough to damage the bricks yet sufficiently effective to remove all old mortar and dirt.

PNEUMATIC CHIPPER FOR CLEANING BRICKS

The work was accomplished on tables. About 100 bricks were cleaned at a time. The bricks were laid side by side on the table. When so placed the bricks formed a comparatively flat surface measuring 12 ft. x 3 ft. The arrangement enabled the operator to clean 100 bricks on one side before turning them for cleaning on the ends and other side.

The labor cost of 40c. per hour was the same as for hand methods. The cost of compressed air averaged two cents per hour per hammer. The cost per thousand bricks exclusive of any charge for tools and equipment, hand cleaned, was $5.55; mechanically cleaned, $1.26.

Electrical Indicator on London Subway

An electric indicating device has been installed on the London Metropolitan Underground Railway. At the boarding steps on each car the passenger is confronted by an illuminated list of stations at which no stop will be made; inside the car, within view of seated passengers, is a similar indicator. Along the center of the car is a series of panels each representing a station, each of which is illuminated in turn to indicate the next stop.

NEWS OF THE WEEK

New York, April 14, 1921

Hudson River Bridge Association to Be Incorporated

At a meeting held in New York City April 6, it was decided to incorporate the Hudson River Bridge and Terminal Association following the meeting of prominent business men last December for the purpose of forming a permanent committee to advance the project of building a suspension bridge across the Hudson River according to plans prepared by Gustav Lindenthal.

The decision to incorporate was through a resolution from the organization committee, the chairman of which is Otis H. Cutler of the American Brake Shoe and Foundry Co. Others on the committee are Samuel Rea, president of the Pennsylvania R.R.; Thomas F. Ryan; L. F. Loree, chairman of the executive committee, Delaware and Hudson Co.; Henry D. Walbridge, president of the Pennsylvania Electric Co., and George F. Post.

The purpose of the association is set forth in a statement issued by the committee as follows:

"To obtain public support for the undertaking, projected by Gustav Lindenthal, an eminent bridge engineer, to build a great double-deck highway and railroad bridge from Manhattan Island to Weehawken, with terminal facilities on both sides of the river for passenger and freight."

Four Candidates Nominated for A. A. E. Presidency

Four candidates for the presidency of the American Association of Engineers have been nominated by petitions and will be voted on at the organization's annual convention in Buffalo, N. Y., May 9-11. They are: Clarence W. Hubbell, consulting engineer, Detroit; Frederic Bass, dean of the department of civil engineering, University of Minnesota, Minneapolis; Harry O. Garman, chief engineer, Public Service Commission of Indiana, Indianapolis; and Daniel L. Turner, chief engineer, Transit Construction Commission, New York.

For first vice-president there have been nominated C. J. Tilden, Washington, D. C.; A. N. Johnson, College Park, Md.; A. B. McDaniel, Camp Dix, N. J.; G. M. Butler, Tucson, Ariz.; and W. J. H. Strong, Chicago.

For second vice-president the nominations are: Raymond Burnham, Chicago; A. S. Morris, Oak Park, Ill.; M. Z. Ralph, Pittsburgh; and W. J. H. Strong.

Where a candidate has been nominated for two positions he will be required to choose the one for which he desires to run.

First Unit of Seattle Powe. Plant Soon Complete

The first unit of the Skagit River Development project which will furnish 3,000 hp., and which is being developed by the city of Seattle, will be completed and in operation by June 15, according to engineer in charge, C. F. Uhden. The unit is known as the Newhalem Creek plant, and will furnish power through the use of a 2,700-ft. tunnel driven through solid rock, and a 900-ft. 36-in. steel pipe line leading from a dam located ¾ mile up Newhalem Creek, through which water will pass to the main power station of the Gorge Creek development. This station will house a power unit consisting of an impulse waterwheel and a 5,600-volt 3-phase generator. Work on the tunnel has been pushed all winter, and an average of from 100 to 105 ft. per week has been maintained in driving this 6x 7-ft. tunnel through exceptionally hard rock with the use of Leyner drills.

National Highway Traffic Convention April 29

The National Highway Traffic Association will hold its 1921 convention at the Detroit Athletic Club, Detroit, Mich., April 29. Sessions will begin at 10.30 a.m., 2.00 p.m., and 8.00 p.m. The convention will be devoted to the presentation and discussion of progress or final reports of standing committees. The following list includes some of the subjects pertaining to traffic regulations and highway transport which have been assigned to committees:

Traffic limit lines on roadway surfaces; design of curves at street corners to facilitate traffic; widths of roadways and sidewalks in municipalities; regulations covering speeds, weights and dimensions of motor trucks and trailers; regulation of overloading of motor trucks; impact forces; curves.

Complete programs may be obtained from the president, Arthur H. Blanchard, University of Michigan, Ann Arbor, Michigan, or from the secretary, Elmer Thompson, Automobile Club of America, 247 West 54th St., New York.

To Control Kankakee River

Governor McCray of Indiana, has appointed Charles W. Henley, of Rensselaer; William Darrach, of Kentland, and Thomas Grant, of Lowell, members of the Kankakee River drainage commission to confer with a similar commission appointed by the Governor of Illinois to prepare a program for straightening and deepening the Kankakee River to prevent floods.

Want Federal Highway Commission Created

In Interview With President, Automotive Delegates Express Views on Need for New Body

(*Washington Correspondence*)

A plea for the establishment of a federal highway commission was made to the President last week by representatives of the automotive industries. It was contended that the administration of the federal government's highway appropriations should not be lodged in a bureau of one of the departments. It was pointed out that the U. S. Bureau of Public Roads is administering the expenditure of a fund greatly in excess of the appropriations of the entire Department of Agriculture.

It is understood that the President will insist upon maintenance being a condition of any future highway legislation. He is said to be of the opinion that the entire proceeds from vehicle licenses should be devoted to maintenance work.

FEDERAL AID CRITICIZED

Roy D. Chapin, chairman of the highways committee of the National Automobile Chamber of Commerce, was at the head of the delegation which called on the President. He told Mr. Harding that the Automobile Chamber of Commerce is opposed to a continuance of federal aid in its present form because he believes the public interest is not conserved fully in the expenditure of the large appropriations which have been made. Mr. Chapin and the members of his committee also discussed highway problems with Thomas H. MacDonald, chief of the Bureau of Public Roads, with the Secretary of Agriculture, the Secretary of Commerce and the Secretary of the Treasury. In reiterating what he has said before Mr. MacDonald outlined his position as to maintenance as follows:

"The task today is to provide highway service; we cannot afford to wait for the construction of new and modern types of highways. The maintenance should be carried forward now on roads improved and unimproved. The returns will more than compensate the cost. If there is one problem which the road builders of the United States as a whole must learn it is that of highway maintenance. The continuity and long radius of operation of the motor vehicle require a development of maintenance organizations and maintenance expenditures not heretofore required; but in the same fact lies, because of the service rendered, the justification for the expense involved. We cannot neglect the simple methods of maintenance which have demonstrated their utility. The harrow, the road drag, the blade grader, have a high degree of utility in combination with the motor truck and gas tractor. One state engineer remarked that the widespread use of these simpler maintenance tools in his state saved his whole program of higher cost construction because of the better highway service provided over a large mileage.

Hetch Hetchy Tunnel Work Now on Open-Shop Basis

Labor is now plentiful on the Hetch Hetchy project and more men are applying for work than can be employed. In the month of March the six headings were advanced a total of 1,714 ft. The best progress was at Priest portal where, on a three-shaft basis, the heading was advanced 494 ft. during the month.

The strike of unionized tunnel workers called on the project last August, at which time 100 men quit work, has never been declared off. At a conference in San Francisco between labor leaders and city officials on April 6 no agreement could be reached and city officials announced that further conferences would be futile. The work is now on the open-shop basis. For some time past a full crew of 322 tunnel men have been in the employ of the Construction Co. of North America and the subcontractors.

The men who went on strike in August did so against the orders of union labor leaders. In October when non-union crews had been recruited and the work was again well under way, the unions recognized the strike and endeavored to arbitrate it on the basis of making the tunnel work strictly a union job. Efforts of union labor in that direction have not met with success.

Prof. W. K. Hatt Appointed Indiana State Engineer

Appointment of William K. Hatt, professor of civil engineering, Purdue University, as chief of the division of engineering of the Indiana state department of conservation has been announced recently. This office, known as state engineer, was created by an act of the recent session of the General Assembly, as noted in *Engineering News-Record*, March 31, 1921, p. 570.

Prof. Hatt was selected for the position by the state conservation commission with the approval of Richard Lieber, director of the conservation department, out of a large field of applicants. The new state engineer, who took office April 11, will continue as a member of the faculty of Purdue University. The arrangement under which the state engineer is a member of the state school faculty is similar to that under which the state geologist, who is a member of the Indiana University staff, is selected. The division of engineering promises to become one of the most important bureaus of the state department. Flood prevention and drainage questions will be among the important problems to be solved by the new division. Pollution of streams by industrial plants will also be investigated.

Prof. Hatt has been connected with Purdue University since 1893, but has had a wide professional experience outside his college work. For a number of years he was consulting engineer for the U. S. Forest Products Laboratory, at Madison, Wis., and during the war was connected with the educational work of the war department. For two years he was president of the American Concrete Institute.

New Ferry for New York-Staten Island Service Proposed

A new ferry route at New York from Cortlandt St., Manhattan, to Stapleton, Staten Island, with a connection at 39th St., Brooklyn, has been recommended by the committee on finance and budget of the Board of Estimate of New York City. Three new ferry boats would be built and a new slip constructed at Stapleton. At Cortlandt St., Manhattan, the boats would operate from the northern slip of the three now occupied by the West Shore and Pennsylvania Railroads. While the lease on this slip has two years to run, it is expected to secure its use in the meantime by arrangement with the railroads

Dock Commission Would Replace Ferry with Piers

The Dock Commission of New York City has decided to construct four piers of 150-ft. width, with 332-ft. slips, on the Hudson River from 36th St. to a point between 42d and 43rd Sts., according to announcement last week of Dock Commissioner Murray Hulbert. This would necessitate doing away with the 42d St. ferry of the West Shore R.R. and with Pennsylvania R.R. piers Nos. 76 and 77. Since the ferry is used by large numbers of commuters from New Jersey a hard fight against the proposal is expected.

San Francisco Harbor Control

A bill is now before the California legislature, with a fair chance of passage, transferring the control of the San Francisco water front from the State to the city. Supervision of the harbor is now vested in the State Board of Harbor Commissioners, an independent body which has administered the state bond issue devoted to port works to such good advantage that the port is practically on a self-supporting basis. There are interests in the city, however, that feel that San Francisco may be militated against by the power of rival cities in the legislature and demand that the state turn over the waterfront to the city, as it has already done to most of the other coast cities. The shipping interests favor state control and others fear the dangers of municipal inefficiency and political control should the city be given supervision of the port.

Federal Highway Council

New members have been elected to the executive committee of the Federal Highway Council, Washington, D. C., as follows: W. J. L. Banham, Otis Elevator Co.; David Beecroft, president, Society of Automotive Engineers; H. W. Alden, Timken-Detroit Axle Co.; and S. P. Leeds, president, Atlantic City (N. J.) Chamber of Commerce.

California Highway Commission Urges Gasoline Tax

The California Highway Commission has issued a statement that begins with the assertion, "The enactment of a tax on gasoline to provide additional funds for state highway purposes is an imperative necessity if the present needs are to be met adequately." Declaring that money now available is insufficient for four needs that have recently arisen and which were not provided for in the $40,000,000 budget, the commission points out that a gasoline tax of 1 cent per gallon will automatically distribute the burden on those who use the highways most.

The four principal needs are enumerated as follows: (1) To widen and thicken main trunk highways where 1,400 per cent increase in motor transportation has made a heavier duty road an imperative necessity; (2) to reconstruct oil-macadam roads taken over into the state system from counties; (3) to assist impoverished cities to construct links of state highway within their incorporated territory, and (4) to supplement bond funds in restoring the balance between 1917-1918 estimated costs and present-day costs in completing the original system and new roads contemplated when the 1919 bond isssue was voted.

The California state tax on automobiles is not only lower than in other states of equal highway development, the commission asserts, but is below the average for the United States. The tax on the average pleasure car in California is $1.58 per annum less than the average. On the 2½-ton pneumatic-tired truck it is $12.53 below average and on the 4-ton solid tire truck $16.12 below average. These figures the commission cites to show that the California tax is especialy low on the type of motor vehicle which is causing the most damage to the highways.

In conclusion the statement says: "California furnishes in return for the taxes exacted from motor vehicles infinitely more in road service than many states of the union, and equals, if it does not lead, the other states in the mileage of improved roads over which a tremendous and ever increasing volume of traffic is handled. In our opinion the motor industry and organizations should welcome a tax adequate to maintain, improve and extend the state system."

Chicago's "Progress" Exhibition

An exhibition representing modern progress in industrial, civic and educational affairs is to be held at Chicago, July 30 to Aug. 14 on the Municipal Pier which extends 3,000 ft. into the lake and provides two parallel buildings or exhibition halls 2,340 ft. long. The building industry section will have a space 280 x 66 ft., and it is proposed that engineers and engineering societies combine in a co-operative exhibit occupying a portion of this space.

Navy Wants Civil Engineers

Applications are being received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., to fill vacancies in the commissioned grade of assistant civil engineer, Corps of Civil Engineers, U. S. Navy, with rank of Lieutenant (junior grade). The pay and allowances at entrance are approximately $3,200 per annum, with increase up to $9,600, depending upon promotions in rank and length of service. The candidate must be an American citizen between the ages of 22 and 30 years on Aug. 1, 1921; must have received a degree in engineering; must have had not less than 20 months practical professional experience since graduation, and must be of good moral character and repute.

Officers of the Corps of Civil Engineers are detailed principally to the various navy yards and naval stations to supervise the work under the Bureau of Yards and Docks, Navy Department, Washington, D. C., consisting of design and construction of all the public works of the naval establishment on shore as well as the maintenance and repair of existing structures.

Move Made To Charter Civil Engineers in Britain

(London Correspondence)

The Institution of Civil Engineers has just issued a notice to its members announcing that steps have been taken to apply to the Privy Council for the grant of a supplementary royal charter to confer the use of the professional description of "chartered civil engineer." This constitutes a new step in the movement on the part of the Institution to define clearly the term "civil engineer." Two alternatives had been previously considered: (1) A private bill, which was found to be impossible; and (2) a public bill, which was rejected by the council of the Institution. It is hoped that the interests of the members of the Institution will be considerably advanced by the establishment of a definite status for the civil engineer.

Seattle Water Department Shows Operating Profit

According to the 1920 report of the Seattle water department, submitted by Superintendent of Water L. B. Youngs, the department showed a net profit for the year of $487,665. The gross income was $1,301,755 and the expenses $810,090. The present water system is valued at $12,011,530, with outstanding bonds of $3,642,135. The report states that in view of the proposed raising of the water in Swan Lake to increase the reserve supply, the department is building dams at the lake to cost $65,000. These dams will permit of the raising of the water level temporarily to test the basin for leakage before beginning the $6,000,000 project, which includes a tunnel and controlling works and new pipe lines. The dam work will be completed next fall, enabling the department to raise the water to its maximum next winter.

Federation's Executive Board To Meet in Philadelphia

The executive board of the Federated American Engineering Societies will hold its next meeting in Philadelphia, April 16, as guests of the Engineers' Club of Philadelphia. A dinner is to be held at the Bellevue-Stratford on the evening of that date and an address will be made by Herbert Hoover, president of the federation.

It is announced by Secretary Wallace that the work of the committee on elimination of waste in industry is progressing according to schedule. Field work will be completed on or before April 15 and the publication of the final report will be undertaken immediately thereafter. It is expected to publish the report some time in June.

Within the last few weeks two societies have joined the federation, the Boston Society of Civil Engineers and the Engineering Society of Milwaukee. The opportunity of becoming a charter member of the federation expires July 1.

I. C. C. Issues Four Supplemental Tentative Valuations

Four "supplemental" tentative valuations, including a report of the Kansas City Southern property, were issued by the Interstate Commerce Commission April 5 as a result of the decision in the Kansas City Southern case requiring the Interstate Commerce Commission to find additional elements of land values such as cost of acquisition, severance damages, etc. In addition to the Kansas City Southern, reports were issued of the Atlanta, Birmingham & Atlantic Co., the San Pedro, Los Angeles & Salt Lake, and the Winston-Salem Southbound Ry.

The reports are issued in the usual way to the carriers, states, and state bodies, with opportunity to protest within thirty days.

University of Colorado Course in Municipal Design

A course in municipal design, embracing the town plan, streets, water-supply and sewer system, is being given in the senior year of the course in civil engineering at the University of Colorado. The course consists of a recitation period and two three-hour drafting periods per week. The recitation period is used to discuss plans made during the drafting periods, the class acting as a board of engineers. The instructor acts only as chairman of the discussions, the students relying on their own judgment in matters of design. The problem consists of laying out lots, blocks, streets, and alleys, and making plans, specifications and estimates of cost for the municipal improvements of an industrial town. This problem is intended to make a useful application of the fundamental courses of surveying, hydraulics, concrete design, engineering materials, and bacteriology as brought out in the course in road and pavements, sewerage, water supply, plans and specifications, and estimates and costs. J. B. Marcellus, associate professor of civil engineering, is in immediate charge of the course.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Seventh Convention, Buffalo, N. Y., May 9, 10 and 11.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Houston, Texas, April 27-30.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York; Spring meeting, Chicago, May 23-26.

AMERICAN WATER WORKS ASSOCIATION, New York; Convention, Cleveland, June 6-10.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual meeting, Asbury Park, N. J., June 20-24.

The North Carolina Drainage Association will hold its annual convention April 12 and 13 at Elizabeth City, N. C., jointly with the North Carolina Geological and Economic Survey. Dr. Joseph H. Pratt, director of the State Geological Survey, Raleigh, N. C., is secretary of the drainage association.

The Rochester Engineering Society, at a joint meeting with the Rochester Rotary Club April 26, will be addressed by J. A. M. de Sanchez, director of the economic division of the French Embassy, on the situation in France.

The Western Society of Engineers' board of direction has approved the following nominees returned by the nominating committee for officers for the ensuing year: President, Charles H. MacDowell; vice-presidents, J. L. Hecht, F. F. Fowle and B. B. Shapiro; treasurer, Homer E. Niesz; trustee for three years, E. W. Allen; members Washington Award Commission for three years, Prof. John F. Hayford and H. J. Burt. Additional nominations by petition must be filed before April 20.

The Southwest Water Works Association will hold its annual meeting May 9, 10, 11 and 12 in Oklahoma City. Features on the program include a paper on "Water Collections" by Miss Adella Martin, city clerk, Newton, Kan., who has maintained a record of 100 per cent collections. Several other women employees and owners will take part in the discussion. Health officials of these states will cover water protection methods and there will be a series of fifty 3-minute illustrated talks by superintendents.

PERSONAL NOTES

C. C. HAIRE has been appointed engineer auditor with jurisdiction over valuation and capital expenditures, on the Illinois Central R.R., with headquarters at Chicago, Ill.

W. P. HAYES, formerly assistant engineer, Missouri Pacific R.R., has been promoted to division engineer on the Louisiana division, with headquarters at Monroe, La.

R. G. BUSH, formerly assistant engineer in the valuation department, Missouri Pacific R.R., at St. Louis, Mo., has been appointed assistant engineer on the Valley division.

W. F. LINEBERGER, who was employed in the construction of ports and later in railroad and hydraulic engineering, was recently elected a member of Congress from the 9th California district to fill a vacancy caused by the death of Congressman C. F. Vandewater. Congressman Lineberger was, for a time, a member of the Harbor Commission of Long Beach, Cal., and during the World War was a captain, Engineers, with the 1st, 32nd and 40th divisions.

HENRY T. SHELLEY, assistant engineer, Bureau of Surveys, and for fourteen years in the employ of the city of Philadelphia, Pa., on grade crossing removal and sewers and sewage treatment works, has resigned to become chief engineer of materials and construction for the Eastern Clay Products Association of Pittsburgh.

C. R. DART, bridge engineer, Sanitary District of Chicago, since 1901, has resigned to open a consulting office in Chicago. His early engineering experience was gained on railroad construction for nine years after graduation from Michigan Agricultural College in 1881 and a post-graduate course in Michigan University. Following employment on the World's Fair at Chicago, he was for a time with S. G. Artingstall, then for one year with Alfred Noble and three years with George S. Morison. Mr. Dart served for many years as the treasurer of the Western Society of Engineers.

P. L. SHEN, Kiangsu Grand Canal Improvement Board, China, expects soon to be in this country for eight months to look into hydraulic works and the U. S. Reclamation Service projects. This board was instrumental in bringing to China the American Red Cross Board of engineers.

HOWARD L. KING, formerly resident engineer on construction of acid phosphate plant by the Pratt Engineering & Machine Co. at East Point, Ga., is now engineering inspector on the Hudson River vehicular tunnel, New York.

HOLTON COOK is now resident engineer with the Kentucky Highway Commission on the construction of a federal-aid road and will be located at Dixon, Ky.

ERNEST E. TUPES, for a number of years a designing engineer with the American Bridge Co., has opened an office in Chicago, for the practice of law in relation to patents, trademarks, copyrights and corporations.

JOHNSON & BENHAM, INC., consulting engineers, of New York and Kansas City, Mo., announce the reorganization of their business. All contracts and business of the New York office have been taken over by the George A. Johnson Co., Inc., the members thereof being George A. Johnson, Harold C. Stevens, Nelson B. Wolfe, Charles R. Wyckoff and Harry B. Joyce. The main offices of the corporation are in New York City. All contracts and business of the Kansas City office have been taken over by Benham & Mullergren a partnership consisting of Webster L. Benham and Arthur L. Mullergren.

N. S. SPRAGUE, until recently chief engineer of the Bureau of Engineering, Pittsburgh, Pa., is now engaged in general engineering practice with offices in the Wabash Building, Pittsburgh.

W. O. SHERMAN, formerly with the Chemical Construction Co., Charlotte, N. C., has been engaged as chief engineer, Carolina Steel & Iron Co., structural steel fabricators, Greensboro, N. C.

WALTER E. SPEAR, formerly department engineer of the headquarters department, New York Board of Water Supply, who was granted a leave of absence to make investigations and reports on water supply and sewerage of Athens and Piraeus, has reassumed his duties as department engineer with the water board.

FRED C. DOOLITTLE, civil engineer and construction foreman, has been appointed highway maintenance engineer for Whitman County, Wash.

EUGENE E. HASKELL, C. E. and M. C. E., Cornell '79 and '90, will retire as dean of the College of Civil Engineering at Cornell University this June, at the end of his sabatic leave.

E. K. HATTEN has been appointed assistant engineer of the Georgia & Florida Ry., with headquarters at Augusta, Ga.

G. H. BALLANTYNE, resident engineer, Western Pacific R.R., with headquarters at Sacramento, Cal., has been appointed acting chief engineer with headquarters at San Francisco, Cal.

J. B. PRIDGEN, formerly in the engineering department of the Atlantic Coast Line R.R., has been appointed engineer of construction of the North Carolina Highway Commission.

W. L. AFFLECK has been appointed city engineer of Nelson, B. C.

A. G. DALZELL, recently in private engineering practice in Vancouver, B. C., is now consulting engineer to the Vitrified Clay Pipe Publicity Bureau, Toronto, Ont.

SAMUEL MOREELL, JR., assistant engineer, structural division, Sanitary District of Chicago, has been made chief structural engineer.

JULIUS R. HALL, acting engineer of bridge design, City of Chicago, has been made principal assistant engineer, Sanitary District of Chicago.

J. O. FRANCISCO, formerly field engineer, Colorado State Highway Commission, is now road engineer of LaPlata County, Col., in charge of maintenance and construction of 1,600 miles of road.

H. M. STAFFLET, recently head of the construction department of Liggett & Myers Tobacco Co., Durham, N. C., and formerly with the Austin Co., has reentered the employ of the Austin Co. as superintendent of construction on a sales and service station to be built for the Hartford Brick Co., East Hartford, Conn.

I. G. HERSHEY, formerly division engineer with the Du Pont Engineering Co., is now superintendent of highway construction with the Souder Construction Co., Lancaster, Pa.

LEONARD MURRAY, for several years associated with Charles E. Eaton, consulting paper mill engineer, is now in the employ of the engineering department, Watertown, N. Y.

RAY E. PALMER, for the past 12 years connected with the New York State Highway Department, with headquarters in Watertown, N. Y., has been appointed assistant engineer on the staff of the division engineer at Hornell, N. Y.

H. J. BAUM, formerly assistant engineer at Johnstown, Pa., has been appointed city engineer of Altoona, Pa.

THOMAS MEAD, formerly deputy engineer, has been appointed county engineer, Whitman County, Wash.

MAJOR CLYDE J. CHAFFINS, resident engineer of the Idaho Bureau of Highways, Sand Point, Idaho, has been made office engineer in the Cœur d'Alene office under W. J. Bassett, district engineer.

ALEJO A. CARREÑO Y. SARDIÑAS, a graduate in civil engineering of Rensselaer Polytechnic Institute (1903) has been elected president of the Society of Cuban Engineers. He was born in Calimete, Province of Matanzas, Cuba, March 25, 1878. After leaving college he returned to Cuba and established the Cavodonga sugar mill, of which he is still manager. In 1914 he built a broad gage railway line of 17 kilometers across the Cienaga de Zapata. Four years later he became assistant engineer in the Department of Public Works having to do with the upkeep of thoroughfares and parks in Havana. During this time, with several of his colleagues, he founded the Society of Cuban Engineers. Much of Sr. Carreño's time has been devoted to the development of the sugar industry and he has made special studies along these lines for American companies in Santo Domingo.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Lower Wages in Building Industry at San Francisco

A 7½-per cent reduction has been decided upon as a proper change in the wage schedule of seventeen building trades by the board of arbitration for the San Francisco bay district building industry. The new wage schedule became effective April 11 and will continue for six months. At the end of that time the wages will again be set to conform to what the board members believe to be fair to both employers and employees.

The arbitration of wage rates first came up when labor organizations in a number of the building trades demanded increases last October. It was then agreed that the matter would be submitted to arbitration as announced in *Engineering News-Record* Feb. 3, p. 239, and that any increases allowed would be made retroactive. No statement was included regarding making decreases retroactive. The board of arbitration, which began its work in January, was agreed upon by representatives of the Building Trades Council and the Central Council of the Builders Exchange, and the San Francisco Chamber of Commerce secured the services of the individuals comprising the board. It was agreed by representatives of employers and employees that the decisions of this board would be accepted as final and that such a body would be regarded as "a continuing board."

The report of the board states that the cost of living in San Francisco increased 85.1 per cent from 1914 to Jan. 1, 1921. "In 1914 the lowest wage paid in any trade was $3.00 a day," the report states. "By applying the 85.1 per cent increase in costs, we find that the wage of corresponding purchase power is $5.55. In this particular trade the wage increases to date have been 100 per cent. Therefore a reduction of 7½ per cent of the present wage is necessary to equalize the wage with the cost of living."

Wage Controversies General in Building Trades

Wage controversies continue as the absorbing problem in the building industry the problem being resolved into either opposition to wage reductions, or voluntary cuts, with demands for increases being reported from time to time.

Denver contractors have adopted the open shop plan of opposing building trades labor after unsuccessful means had been tried to force employees to acknowledge the action of the state industrial commission in authorizing a 10 to 12-per cent decrease. Consequent to building trades difficulties in Massachusetts, best expressed in the Boston situation where the state arbitration board has taken a hand in the settlement of a strike that was called in January, a move has been started to organize employers all through the state to hold out for a 20 per cent decrease. Employers are using the strike in several Massachusetts towns as a protest against wage cuts.

Fights against wage reductions are acute in other places than Massachusetts, Rochester reporting serious difficulties over a proposed 15-per cent reduction, with the possibility present of the state industrial commission interposing. Failure to agree on 1921 wage agreements has practically tied up building operations in Ohio cities, except in Columbus. The Newark Building Trades Council of some 8,000 members has rejected a proposed wage cut, as has Walla Walla, Wash.

In Chicago some of the building trades unions have voted to accept a 20-per cent reduction, advocated for all trades by the Chicago Contractors Association. Other Chicago unions stand firm against a reduction. Springfield, Ill., carpenters have accepted a decrease of 10 cents an hour. Bricklayers of Spokane, Wash., have voted to accept a 10-per cent reduction and the plumbers of Wilmington, Del., have offered voluntarily to reduce wages in order to stimulate building, other trades promising similar action.

In the face of an announcement that Albany, N. Y., building trades employers would cut wages 25 per cent on May 1, the new proposals of the building trades council members contain a demand for a 10-per cent increase for hoisting engineers.

Department of Justice to Watch Building-Material Interests

The Department of Justice will inform itself as to the prices of building material at important centers throughout the country it has been announced. The Attorney General states that the Department has evidence of the existence of questionable practices in the handling of building materials in Washington, Pittsburgh, St. Louis, Cleveland and Chicago. The Department will lend active aid to the local officials in an effort to break up price fixing and other violations of the anti-trust laws. The Attorney General has made it clear that he will make a determined effort to break up the various practices which look to price raising. In sounding a warning to the building material industry, he stated that it would be well for other business interests to take note.

Steel Corporation Cuts Prices

Structural Shapes Down $5 Per Ton—Rail Prices Unchanged

On April 12 the United States Steel Corporation announced a price cut, effective immediately, by which structural shapes are reduced $5 per ton, plates $9, bars and wire rods $9, plain wire $7, sheets and small billets $8, slabs $4, 4 x 4 and heavier billets $1.50, and $15 for tin plates, all f.o.b. Pittsburgh. In some instances the new prices are higher than those of the independent manufacturers, notably in the case of plates. Again, in the case of billets, the Corporation price is slightly below independent quotations. There were no price reductions on rails or nails. This is the first price revision by the United States Steel Corporation since March, 1919, when prices were fixed by the Industrial Board.

Pennsylvania and New York Open Bids on 162 Miles of Road

On April 1 the Pennsylvania State Highway Department opened bids for the construction of approximately 80 miles of highways. On April 5 the New York State Highway Commission opened bids for the construction of the same mileage. Though there is no basis for comparison in the prices submitted in the two states some interesting details are apparent in the examination of the two bids.

In the State of New York the engineer's estimate for the 80 miles was $3,287,092, and the sum of all the low bids was $3,033,292, or $253,800 below the total engineer's estimate. In other words, the sum of the low bids was 92 per cent of the total estimate. In New York on only one project were no bids submitted, most projects attracting from four to seven bidders. On the 22 projects on which bids were submitted, there was a total of 85 bidders. Inasmuch as the total of the high bids was 97 per cent of the estimate, the range between low and high bidders was necessarily small.

In Pennsylvania, bids were received for the construction of the following types: (1) Bituminous surface on concrete base, or one-course reinforced concrete, 38 miles: (2) one-course reinforced concrete, 18 miles; (3) one-course reinforced concrete and Hillside brick, 21 miles; and, brick, 3½ miles. On Type 1, the average per-mile cost of the low bid was $60,500. The average per mile cost on Type 2 was $67,500, on Type 3, $69,000, and on Type 4 $78,000. The sum of low bids submitted for all types, distributed among 24 projects was approximately $5,400,000. This shows an average per mile cost of all types of about $66 000 per mile.

Road Bids Decrease Six Per Cent in Six Weeks

Same Contractor Low on Both Bids in Two of Fifteen Projects—Many New Bidders

On Feb. 18 the Pennsylvania State Highway Dpeartment received bids for the construction of approximately 100 miles of modern-type highways but the bids were rejected on the ground that they did not reflect the downward trend of prices of labor and materials. Most of the projects included in the Feb. 18 opening were re-advertised and re-opened on March 31, and a comparison of the low bids in the two openings indicates that within the six weeks' period of time a decrease of 6 per cent in the bid price is noted.

In the analysis and comparison of these two sets of bids, shown in the accompanying table, several facts are to be noted. In the first place, in every case but one the low bid of March 31 was considerably lower than that of Feb. 18. In that one case it is apparent that the contractor's estimate was unreasonably low, inasmuch as the next low bidder on Feb. 18 was 20 per cent higher than the low bid. The low bid on that particular project, which is noted in the table as Route No. 95 in McKean County, was considerably lower than the average of all bids received on that project Feb. 18.

When bids were opened on the projects March 31 it was apparent that a number of new bidders were in the list. In most cases the same bidders who bid on the project Feb. 18 revised their bids and submitted them for opening March 31, though in a few cases the first bidders dropped out entirely. The total low bid of Feb. 18 was $5,253,752, whereas the total low bid for the same project March 31 was $4,939,678, a saving of $314,074.

TABLE I—COMPARISON OF BIDS OPENED FEB. 18, READVERTISED AND REOPENED MARCH 31—PENNSYLVANIA HIGHWAY DEPARTMENT

Project	Length in Feet	Type	Low Bid, Feb. 18	Low Bid, March 31	Increase or Reduction	March 31 Bid of Low Bidder Feb. 18
Allegheny Co. Route 246	14,556	A	$212,709	$191,095	— 21,614	$210,611
Beaver Co. Route 204	26,953	A	373,017	347,676	— 25,341	360,449
Bucks Co. Route 156	67,069	A	1,109,520	1,008,567	— 100,953	1,069,582
Bucks Co. Route 151	36,706	A	456,900	417,713	— 39,187	446,070
Bucks Co. Route 28	16,010	A	226,816	211,416	— 15,400	218,991
Clearfield Co. Route 313	25,426	A	334,416	320,665	— 13,751	320,665
Crawford Co. Route 82	24,787	B	283,464	276,022	— 7,442	Didn't bid
Crawford Co. Vernon twp. Route 82	18,619	C	319,966	306,844	— 13,122	307,329
McKean Co. Route 95	32,199	B	382,999	412,117	+ 29,118	Didn't bid
McKean Co. Route 96	6,188	C	119,123	99,743	— 19,380	113,138
Northumberland Co. Route 18	18,957	B	255,185	227,219	— 27,966	Bid rejected
Northumberland Co., Route 161	26,200	A	306,203	294,111	— 12,092	294,111
Tioga Co. Route 196	41,843	B	566,465	538,614	— 27,851	575,813
Warren Co. Route 181	16,137	A	211,255	198,299	— 12,956	198,299
Westmoreland Co. Route 68	6,895	A	95,714	89,577	— 6,137	Didn't bid
Totals	379,545		$5,253,752	$4,939,678	—$314,074	

A. One-course reinforced concrete. B. Bituminous surface on concrete base, or reinforced concrete. C. One-course reinforced concrete and Hillside brick.

Hoover Meets Technical Editors

Herbert Hoover, Secretary of Commerce, discussed with technical and trade paper editors on April 12 the problems of the Department of Commerce with the purpose of developing ideas by which the department might be of greater service to the industries of the country.

Federal Reserve Banks Report Increase in Building

An increase in building is remarked in the March reports of the member banks of the Federal Reserve Board. The district reports follow:

District No. 2 (New York)—Forty-eight per cent of the value of building contracts in February was for residential purposes as compared with 40 per cent in January.

District No. 4 (Cleveland) — Thirteen cities show 1,335 permits for new construction, with a total value $1,813,916 in February, as compared with 872 permits with value of $1,631,924 in January.

District No. 5 (Richmond)—Twenty-three cities show 894 permits issued for new construction during February, in comparison with 624 permits in January.

District No. 7 (Chicago) — Increase in number of building permits. Of 334 permits issued during February in the city of Chicago, 181 were for residence construction.

District No. 8 (St. Louis)—Five leading cities report further heavy falling off in number and dollar value of building permits.

District No. 9 (Minneapolis)—Nine largest cities report 783 contracts with a total value of $2,179,784 for February—an increase of 34 per cent in number and of 152 per cent in value as compared with January; and an increase of 9 per cent in number, but decrease of 3 per cent in value, as compared with February, 1920.

District No. 10 (Kansas City)—Sixteen cities show 1,352 building permits issued, 526 more than January permits and 78 less than permits issued in February, 1920. The fact that the total value of permits was less than in January is believed to indicate that more attention was given to the building of residences and fewer permits were issued for larger buildings.

District No. 11 (Dallas)—Total building-permit value shows an increase of approximately 50 per cent over January, but a decrease of more than 53 per cent from the total value for February, 1920.

District No. 12 (San Francisco)—Twenty cities report during February an increase of 31.6 per cent in value and 12.8 per cent in number of permits issued, as compared with January. Portland, Oakland, San Francisco, Los Angeles and Pasadena report a marked increase of building activity with downward movement of the cost of materials and labor.

Contracts for Past Week Are More than $23,000,000

Due to the number of small contracts let in street and road construction, and the continued strength in miscellaneous building, the aggregate value of contracts for the past week as reported in *Engineering News-Record* is in excess of $23,000,000. The largest figures are: Miscellaneous buildings, $9,865,279, and streets and roads, $8,365,302.

As an indication of how these contracts average in value the total cost of street and road contracts is spread over 95 projects, and miscellaneous building, 58 projects. Industrial building shows a substantial increase over the March weekly average, the total value of contracts let being $3,911,000.

The largest road projects let were nine contracts awarded by the Pennsylvania Highway Department for a total of $1,975,700, those projects being among the ones readvertised March 31.

Power Company Plans Extensive Work in Next Ten Years

In a rate hearing before the California Railroad Commission on March 30, John A. Britton, vice-president and general manager of the Pacific Gas & Electric Co., presented figures to show what the company proposes to do in construction in the next ten years.

From 1910 to 1920 consumers on the company's system increased from 73,500 to 266,132 and based on this previous record and the situation today, Mr. Britton estimated that by 1930 the peak demand would total 570,000 hp.

To meet this expected increase in demand, the company plans to expend within the next ten years a total of $161,000,000 in its power, water, gas and railway departments. Of this total about $138,500,000 will be required for the development, delivery and distribution of power from the Pit River where construction is now under way on a chain of large hydro-electric generating stations.

Record Car Surplus Reported

A record car surplus on March 31, 1921, is shown by tabulations of the Car Service Division of the American Railway Association. On this date there were on sidings throughout the country 495,904 surplus freight cars, the largest number in the history of American railroads, an increase of 36,493 over the total on March 23, or an increase of 82,000 within a month. It is stated that the increase is due entirely to the falling off in coal shipments. Of the total surplus slightly more than half, or 255,055, consists of coal cars, compared with 172,850 on March 1. During the week ending March 26 only 122,189 cars were loaded with coal, the smallest number in one week for some years. The surplus of box cars on March 31 was 171,119, or 6,900 more than on March 23, but 2,400 below the total on March 1.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 7, the next, on May 5.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb	$3.33	$4.25	$3.75	$3.58	$3.51	$4.65	$4.45	$5.00	$5.00
Structural rivets, 100 lb	4.85		7.05	5.08	5.30	6.90	7.05	6.25	8.50
Reinforcing bars, ¾ in. and larger, 100 lb	3.23	3.75	3.85	3.48	3.53½	4.22½	2.35	4.50	4.25
Steel pipe, black, 2½ to 6 in. lap, discount	43%	45-65-5%	40@45%	53¼%	46.9-5%	29@33%	44@47	40%	5%
Cast iron pipe, 6 in. and over, 100 ton	63.30	64.00	66.20	64.10	67.80	70.00	87.65	73.00	80.00
Concreting Material:									
Cement without bags, bbl	3.10 (del.)	3.00	2.85	2.17	2.41	3.10	3.09	3.10	3.44
Gravel, ¾ in., cu.yd	2.50	2.75	1.75	2.75	2.00	2.50	2.50	1.50	1.50
Sand, cu.yd	1.25	1.50	1.75	2.75	1.00	1.10	1.65	1.50	1.50
Crushed stone, ¾ in., cu.yd	2.15	2.50	3.20	2.75	2.25	3.50	2.50	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	48.00	37.50	45.00	55.00	41.00	47.00	27.00	28@30	120.00
Lime, finished, hydrated, ton	21.00	18.00	25.00	20.00	29.00	32.00	25.40	24.00	30.00
Lime common, lump, 200 lb. bbl	3.30	1.65	2.50	1.65	2.00	3.20	2.25	2.75	15.00
Common brick, delivered, 1,000	18.40	12.00	25.00	12.00	18.00	16.00	18.00	19.00	18.00
Hollow building tile, 4x12x12, block	Not used	0.14	0.21	.12	.06	.11	.12½	.13	.28
Hollow partition tile 4x12x12, block	....	.15	.19½	.096	.104	.11	.14½	.11	....
Linseed oil, raw, 5 bbl. lots, gal	.67	.69	.88	.78	.75	.97	.88	.79	.95
Common labor, union, hour	.75@.80	.35	.60@1.00	1.00	.50	.50@.63½	.81¼	.75	....
Common labor, non union, hour	....	.25	.40@.60	.50	.50	.37½@.50	.50@.55	.50	.30@.40

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 *and* 5 per cent; 45@50 means a range of 45 *to* 50 per cent. **New York** quotations are delivered except tiles, which are "on trucks." Sand, gravel and crushed stone are quoted alongside dock. **Chicago** quotes hydrated lime in 50-lb. paper bags. **Minneapolis** quotes on fir instead of pine. Brick is $18 delivered, 16 on cars. Gravel, sand and crushed stone quoted at pit. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of per cu. yd. **Dallas** quotes lime by the 180-lb. bbl. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir, instead of pine; and on lime in paper bags. **Montreal** quotes sand, stone and gravel per ton, and lump lime by the ton. No organized common labor in Montreal.

Changes Since Last Week

The continued depression in the construction materials market is ascribed largely to the feeling that is prevalent among prospective builders that prices ought to decline near to the pre-war levels. Such an attitude is of course unreasonable. Before the war, prices were advancing steadily in practically every industry; therefore, had there been no war, prices would now be higher than in 1914. Not only have production costs increased heavily, but handling charges are seriously high. The freight item alone is 138 per cent above the 1913-1914 figure for finished steel products from Pittsburgh to New York. Another reason for normally higher building costs is the more restrictive city and state building codes now in effect.

Common brick producers selling to the New York market are quoting $15 to $16 alongside dock, as against $15 to $17 a week ago. The labor difficulties anticipated have been postponed to Apr. 18. On the basis of $15, the dealers' price is the wholesale price plus 10 per cent plus cartage, about $18.40 per 1,000.

On April 7 the brick interests in Chicago announced a $4 cut, the present delivered price being $12. It is reported that one of the smaller brick concerns in St. Louis has reduced its price $5, to $10 per 1,000, and face brick from $24 down to $12.

The dealers' price for cement in New York is still $3.10 net (40c. per bbl. extra for bags); the manufacturers' price to dealers being $2.40 alongside dock. Changes in effect Apr. 9 are: Detroit $2.43, instead of $2.51; Indianapolis $2.43, against $2.31; Toledo $2.49, against $2.51; Peoria $2.45, against former price of $2.43. The price at Minneapolis is $2.41; delivered, $2.70.

A few weeks ago the independent steel companies cut prices under the Steel Corporation schedule so long maintained. These prices were $2 per 100 lb., and even lower, as compared with the $2.45 base of the Corporation. Following the announcement that the Republic Iron and Steel Co., of Youngstown, would advance bars, plates and shapes $2 per ton, most of the large independents indicated that they would adopt the same schedule, making bars $2.10 per 100 lb. and plates and shapes $2.20. The advance is ascribed to necessity.

That steel business is not brisk is indicated by the fact that unfilled orders on the books of the United States Steel Corporation were 649,102 tons less in March than in February. Total orders on March 31 amounted to 6,284,765 as compared with 6,933,867 tons on Feb. 28 and 9,982,075 tons in March 1920. In an effort to overcome this condition, the United States Steel Corporation on Apr. 12 announced a new price schedule, as outlined on p. 660 of this issue.

The small demand for steel plates has induced the independent steel manufacturers to abolish the 20c. differential, making the price the same as for structural shapes, $2.10 in Pittsburgh. The warehouses are doing the same. New York dealers quote $3.33 for both plates and shapes; Minneapolis, $3.51. Structurals are down, also, in Denver and San Francisco. The only change in cast-iron pipe is a $2 drop in Seattle. Steel pipe is down in San Francisco. Minneapolis expects a drop in both steel and cast-iron pipe in a week.

The lumber market is hardly in a state to be analyzed. Fir in Seattle has declined from $35 per M. ft. b.m. to $28@$30, thus comparing more favorably with the San Francisco price of $27. There were advances of $2.50 and $2, respectively, on pine, in Atlanta and Chicago.

Chicago reports that the Building Trades Council is still balloting on the proposition to accept a 20 per cent cut, and that on April 9 fifteen unions had accepted and a like number had rejected. The carpenters and bricklayers had not then voted.

The new schedule of wages for the San Francisco building trades, as announced on p. 660 of this issue, was effective April 11.